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## Asynapsis and Triploidy in a Population of *Liatris ligulistylis*<sup>1</sup>

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Irregularity in division at first metaphase of pollen-mother-cells of plants has frequently been associated with hybridity. The normal arrangement of bivalents is replaced by the occurrence of some univalents along with bivalents and sometimes also with trivalents. In 1928 Beadle and McClintock reported a disturbance of meiosis in maize which resulted most frequently in showing only univalents and progressively fewer cells with one, two or more bivalents. In 1930 Beadle showed that this asynaptic behavior of the chromosomes was the expression of a single recessive gene. His analysis added another cause for the aberrant behavior of chromosomes at meiosis similar to that found in many interspecific hybrids. The finding of triploid embryos in plants produced from the cross asynaptic by normal also gave evidence that the asynaptic gene could provide a mechanism for the formation of polyploids.

Thus, when asynapsis, as well as triploidy, appeared in one population of *Liatris ligulistylis* (Nels.) K. Sch. growing in the experimental plot, a study was made of its possible cause. This seemed the more significant because the species had been considered to be the other parent of a hybrid with *L. squarrosa* (L.) Michx., called  $\times L. creditonensis$  Gaiser, which had the diploid chromosome number with regular bivalent formation at the first metaphase (Gaiser, 1951a).

The *Liatris* accession #15 was obtained under an erroneous name from a nursery in May, 1929, as two plants, here referred to as X and Y. By June one plant was already in bloom, giving an erect stalk with large well-spaced heads, of which the apical one was noticeably the largest. As there was question about the identity of these two plants, a plot of seedlings was grown from a packet of seeds obtained from

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<sup>1</sup>The author is grateful to Dr. Paul C. Mangelsdorf for helpful criticism of this paper.

the nursery at the same time the plants were purchased and reported to represent the same population. Twelve of these had bloomed by September, 1930. Eventually sixteen (numbered 1 to 12, A, D, S, and Z) and two self-sown seedlings (Nos. 13, 14) as well as the two original plants were studied. Much later, after comparison with plants received from both Alberta and Saskatchewan this accession was identified as *L. ligulistylis* (Nels.) K. Sch.



Photographs of *L. ligulistylis* #15 population (reduced in reproduction), taken July 14-21, 1934, in plot at Crediton, Ontario, on same scale, approximately one-twelfth natural size. FIG. 1. Plant X obtained from a nursery in spring, 1929. FIG. 2. One stem each of plant X (on left) and twelve seedling plants Z, 1, 2, 3, 6, 7, 9, 10, 11, 12, A, and S, respectively, of May, 1929, from seed reported to be of the same population as plant X. FIGS. 3-9. Plants S, Z, 7, 3, 1, A, and 12, respectively.

#### PLANT COMPARISONS

As a record of this population, a photograph was taken during a two-week period of each plant that was still living in 1934 on the same scale as that of the original plant X (Fig. 1). As all cannot be repro-

duced here, Fig. 2 is included to show a single stem of each. There was only one other plant as tall as 7 (in the center), and that was plant S (on the extreme right). Figures 5 and 3 allow a better comparison of these two tallest plants with typical *L. ligulistylis* as seen in Fig. 1 and also in Figs. 6, 7, and 8 of plants 3, 1, and A, which stood in the row with them. Though plant 7 varied from these in height and the slightly larger size of heads, it was similar to them in such general characters as number and thickness of stems, number of heads on an inflorescence stalk, and shape of leaves and heads. Plant 7 was distinctive merely as the most all-around vigorous plant among them. The tall plant S, equaling it in height (Fig. 3), had a greater number of more slender stems, narrower and more numerous cauline leaves and more cylindrically shaped heads having somewhat ovate phyllaries and fewer florets which came into bloom later than the rest. Plant Z (Fig. 4) was the only other one that resembled it in these characters. These two plants were certainly atypical. Plant 12 (Fig. 9) was typical of the species, being indistinguishable from the previous ones of Figs. 1, 6, 7, and 8.




A comparison was also made mostly of head characters such as those of flower parts, phyllaries, etc., during a three-day period and these are found in Table 1. This shows that plant 7 had a large number of florets and a long corolla tube and achene in comparison with most of the other plants. However, it did not exceed the others in all of these characters. Seedling A had a larger number of florets per head and was nearly equal to it in length of achene and pappus while seedling 4 equaled it in length of corolla and pappus. Thus there were some small variations from plant to plant as is expected in any species. The most significant differences were in the shape and arrangement of the phyllaries and those observations have been confirmed by re-examination of the herbarium specimens. In typical *L. ligulistylis* (Gaiser, 1946) the phyllaries were described as "erect, with less rounded, more irregular, spatulate, broadly lacerate, scarious, usually colored tips." Records and diagrams made of the phyllaries of these plants indicate that several of them had phyllaries of more regular margins which were described as "broadly ovate" in S, and "round-tipped" in Z. This difference in shape combined with their more compact arrangement gave the effect of a comparatively more trimly spicate inflorescence shown (Fig. 2) in plant S (on the extreme right) and in plant Z (second from the left). Their relatively smaller number of florets per head was also re-checked in the herbarium specimens. Of the population, these two suggested some hybridity in *L. ligulistylis*.

#### CYTOLOGY OF PLANTS

Meiotic divisions were missed in 1931, as this species surprisingly bloomed the earliest of all grown in the plot in southwestern Ontario. Cytological studies of this population were begun in the following year with repeated examination of some plants in succeeding years. From first<sup>2</sup> as well as second<sup>2</sup> division figures in pollen mother cells, the

<sup>2</sup>Abbreviations used hereafter: metaphase plates of first and second division = IM and IIM, respectively.

Table I - Characters of heads of plants of *L. ligulistylis* population No. 15

Plant No.	No. of Florets per head <sup>1</sup>	Length of Corolla	Length of Style	Length of Achene <sup>2</sup>	Length of Pappus <sup>2</sup>	Phyllaries					Length of Peduncle	Nature of Peduncle <sup>9</sup>
						No. <sup>3</sup>	Color <sup>4</sup>	Margin <sup>4</sup>	Shape <sup>5</sup>	Nature <sup>4</sup>	Arrangement <sup>4</sup>	
X	43	13	23	5.5	8	30	green red m.	scar. irreg.		bul.	erect	14 +
I	41	10	18	5	8	26	green red m.	scar. irreg.	"	bul.	erect	14 +
2	36	11	15	5	8	28	green	scar. irreg.	"	bul.	erect	40 +
3	19	11	18	5	9	19	green	scar. irreg.		bul.	erect	3-4 -
4	38	14	24	-	10	23	green red m.	- -	"	n. bul.	appres.	4-5 +
6	32	14	16	5	7	30	green red m.	scar. reg.	"	bul.	erect	15 + +
7	46	13	20.5	6.5	10	26	red	scar. irreg.	"	bul.	erect	10 + +
9	34	11	19	6	10	26	green	scar. reg.	"	bul.	erect	30 + +
11	36	11	16.5	5	7	29	green	scar. reg.	"	bul.	erect	20 +
12	36	11	17	5.5	9	30	green	scar. reg.	"	bul.	erect	23 -
A	63	- -	21	6	9.9	36	green red m.	scar. reg.	"	bul.	erect	22 +
S	25	11	18	5	8	21	green red m.	s. scar. reg.		n. bul.	appres.	3 +
Z	33	13	21	5	9	23	green red m.	s. scar. reg.	"	n. bul.	appres.	15 +

\*All characters were recorded Aug. 1-3, 1934, except those of plant 4 which had to be taken at a later time because of later flowering that year. Measurements of length are in mm.

<sup>1</sup>This count was taken from one of the lower heads of each plant which accounts for the smaller number of florets than usually given for the species.

<sup>2</sup>As all measurements were made when the style was exerted, the achene and pappus were immature at that time.

<sup>3</sup>This was the number of clearly visible outer phyllaries without dissection of the hidden innermost smaller ones.

<sup>4</sup>Use of abbreviations: for color, red m. = red margin; for nature of margin, scar. = moderately to very scarious, s. scar. = very slightly scarious, irreg. = irregular to lacerate, reg. = regular or entire; for nature of phyllary, bul. = puckered or bullate, n. bul. = hardly or not at all bullate; for arrangement, appres. = somewhat appressed.

<sup>5</sup>With minor variations, the broader, upper phyllaries could be classified as being generally spatulate-truncate as in diagram 6, spatulate-oblong as in diagram 7, or broadly ovate as in diagram 8.

<sup>9</sup>When peduncle was very slightly pubescent it was indicated -; when slightly so, +; and when noticeably so, + +.

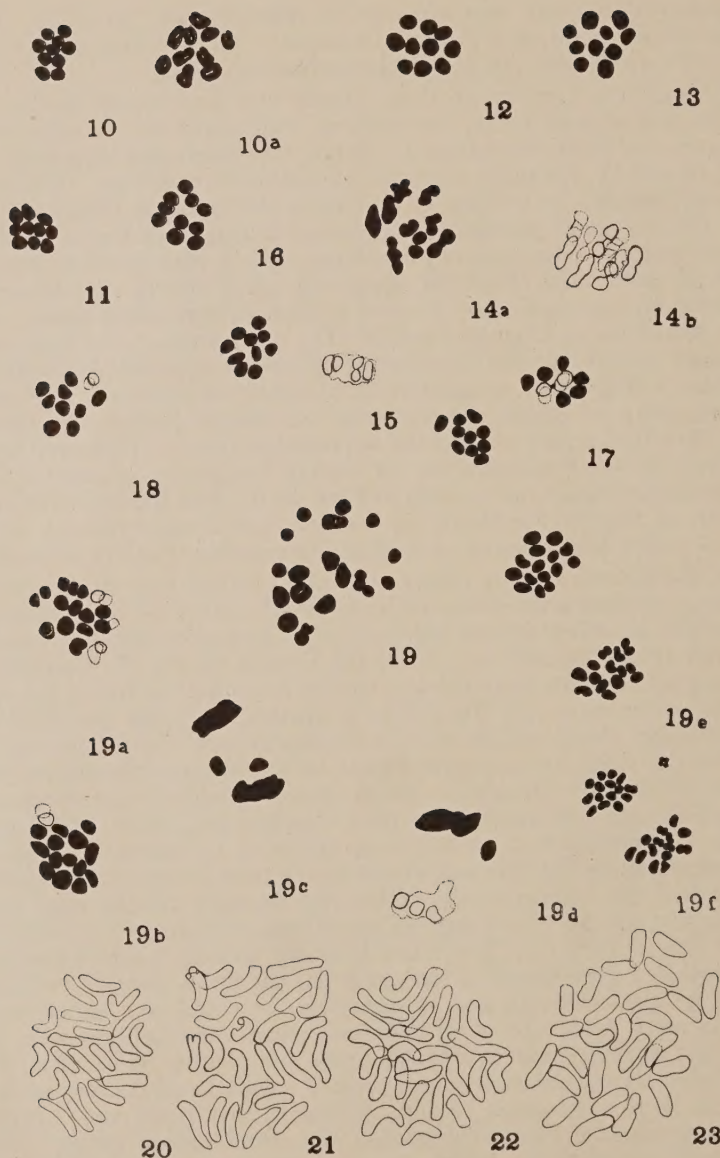
chromosome number was seen to be regularly 10 (see Figs. 10–18) in all but one plant, or a total of 19 plants. The one exception, plant 7 (Fig. 19), was a near triploid in chromosome number.

Though the genome of these plants was seen many times, often as ten well-spaced units, no striking differences in the size of the chromosomes could be detected. When they were close together, as in Figs. 10 and 11, the units appeared almost uniform in size. When they were well-spaced, as in Figs. 12 and 13, a little more variation could be seen, but, as found generally in species of *Liatris*, they formed a closely graded series. When the chromosomes were a little swollen from the effect of acetic acid (Fig. 10a) especially after having been somewhat flattened by pressure, they showed a typical tetrad-ring shape. Also when seen thus in lateral views IM (Fig. 14a) some of the larger units appeared tetrad-like but mostly the bivalents appeared elongated, as dumbbells (Fig. 14b), suggestive of telomitic attachment, due to the pulling away of small chromosomes on slender connecting threads. Once they had separated they all appeared rounded. From cell to cell, as shown in the drawings made for each of the plants, no greater variation was found than can be seen in Figs. 10 to 18 of IM and IIM stages of some of them. Regularity in division was characteristic of all but plant 7 where the behavior as well as chromosome number differed.

In IM figures of this exceptional plant which was studied in two seasons, it was sometimes impossible to decide just which were bivalents<sup>3</sup> and which univalents.<sup>3</sup> In different cells there were differing numbers of units (Fig. 19a and b). Although several of the chromosomes as drawn may be taken as trivalents, careful examination during the study did not show any. In Fig. 19 of a particularly clear plate of well-spaced units, three smaller ones at the upper left, one at the top, and four to the right, may be univalents, while through the center there appear to be 10 bivalents. Other plates could be interpreted as 9II and 6I. It was possible to have counts from 15 to 19 according to the interpretation of overlapping bivalents or separate univalents. The cell shown in Fig. 19 came closest to the perfect triploid complement of 10II and 10I. Irregularities on the first division spindles were found. Frequently one or two straggling chromosomes were seen in late telophase (Figs. 19c, d). Yet sometimes an almost equal number of chromosomes were found to have reached the poles after first division, as in Fig. 19e, where 14 and 15 chromosomes could be counted on the two plates of IIM. In other cells two small chromosomes were seen lying in the peripheral cytoplasm away from either plate (Fig. 19f). Completed second division stages showed a variety of microsporocytes. In some there were seven or eight cells of nearly equal size; in others two very small nuclei accompanied the usual tetrad group. There was great variation in size of the resultant pollen from small micro- to giant-grains.

For a comparison of the somatic chromosomes, root-tips were obtained from germinated seeds of plant X, particularly for the typical, and of plant 7, the triploid. Figure 20 shows the diploid number ( $2n=20$ ) in the former. Longer, intermediate and shorter chromosomes

<sup>3</sup>Abbreviations used hereafter: bivalents=II, univalents=I.



FIGS. 10-19, 24-33 (excepting 33e). Meiotic chromosomes of *L. ligulistylis* #15 population, as seen in polar views (unless otherwise stated) of IM and IIM, from aceto-carmin preparation, drawn by Zeiss apochromatic lenses and camera lucida, reproduced at approximately 1200 mag. Where one chromosome lay above another, a continuous line is used to represent the one in upper focus, and a broken line that in a lower focus. FIGS. 10, 10a, 11, 12, 13, 16, 18. IM plants X, Y, 1, 13, A, and Z. FIGS. 14, 14a and b. Lateral views of IM plant 9. FIGS. 15, 17. IIM plants 12 and S. FIG. 19. Plant 7. 19, 19a and b. IM. 19c and d. I telophase. 19e and f. IIM.

could be distinguished, but the lack of any abrupt change from one class to the next made it difficult to determine the exact numbers of each. At least two pairs were longer, one pair with median and the other with submedian chromosomes. The remainder showed a gradual decrease in length from the longer intermediate ones to two or three shorter pairs. None of these showed striking morphological characteristics. They were slightly bent or open V-shaped rods.

The karyotypes in three germinated seeds of plant 7 are shown in Figs. 21, 22, and 23. The chromosome number in each of the two former is 25. The higher number of chromosomes appears to be due to an increase in the number of shorter ones. In each of the cells drawn there are approximately ten short rod-like or curved chromosomes. Though it cannot be definitely determined whether any of the additional chromosomes are of the intermediate length, at least there seem to be no extra ones of the long type. In Fig. 23 where all the chromosomes were somewhat condensed and appear shorter, 27 units were counted. The proportion of the shortest class is again high and two additional ones could account for this higher total. As there did not appear to be overlapping units or adherence of two chromosomes in the cells seen with 25 chromosomes, different embryos would seem to have had varying chromosome numbers. This would be expected from the irregularity of division seen in the cells giving rise to the pollen, for there would undoubtedly be a lack of regularity in the megaspore divisions also. In any root-tips studied, the count varied from 24 to 28, but the perfect triploid number of 30 was not encountered.

#### FERTILITY OF PLANTS

Seed was collected in 1933 from eighteen plants. While there were unfilled achenes in each, plants 7, 10, 11 and A were reported as having high percentages of such. The seed of plant 11 was considered the poorest. However, when 50 good seeds of each were planted in the greenhouse in December the percentage of germination was generally high. The only plants with a lower than 50% germination were 6, 5, 4, and D and since the latter three did not survive the following winter, there may have been some explanation for their poor seed germination in the condition of the plants. The remaining plants were tested again a second time after the 1934 season by planting 30 seeds of each in January, 1935. The results proved amazingly consistent as shown in Table 2A, including the near triploid plant 7, which gave a higher than 70% germination in both years. As stated (Gaiser, 1951b) where the percentage of unfilled achenes is very high, well filled achenes are more distinctive. Thus, it is possible that the comparatively high percentages of germination in such plants could be explained by the fact that only better ones would tend to be selected.

#### CYTOLOGY OF THE PROGENY

The seedlings of December, 1933, were transferred from the greenhouse to the garden in May, 1934, where an original population of 536 plants was started. It was the intention to watch for any variants

Table II—Fertility\* of Plants of *L. ligulistylis* Population #15 and Conditions of Chromosome Conjugation in Their Progeny

No. of Plant	A. Fertility of Plants		B. Condition of Chromosome Conjugation			
	Percentage Unfilled Achenes 1933	Percentage Germination 1933	Percentage Germination 1934	No. of Progeny Examined 1934, 788 Showing		
				Regular Bivalents	Complete Asynapsis	Asynapsis +1 Bivalent
X	int. <sup>1</sup>	52	43	1		
Y	int.	66	--2	1		
1	low	50	56	1		
2	low	64	60	1		
3	high	74	70	1		
4	high	44	--2	2		
5	high	30	--2	2		
6	high	36	30	2		
7	very high	72	73	---		
8	high	76	--2	2		
9	very low	64	86	1		
10	very high	70	73	1		
11	very high	62	66	2		
12	low	76	73	14	3	1
A	very high	58	50	9	2	1
D	low	44	--2	1		
S	high	74	90	1	1	
Z	low	60	86			
18 Total	---	--	--	42	6	1
						2

\*Determined by germination of 50 achenes each of the 1933 season and 30 achenes each of the 1934 season.

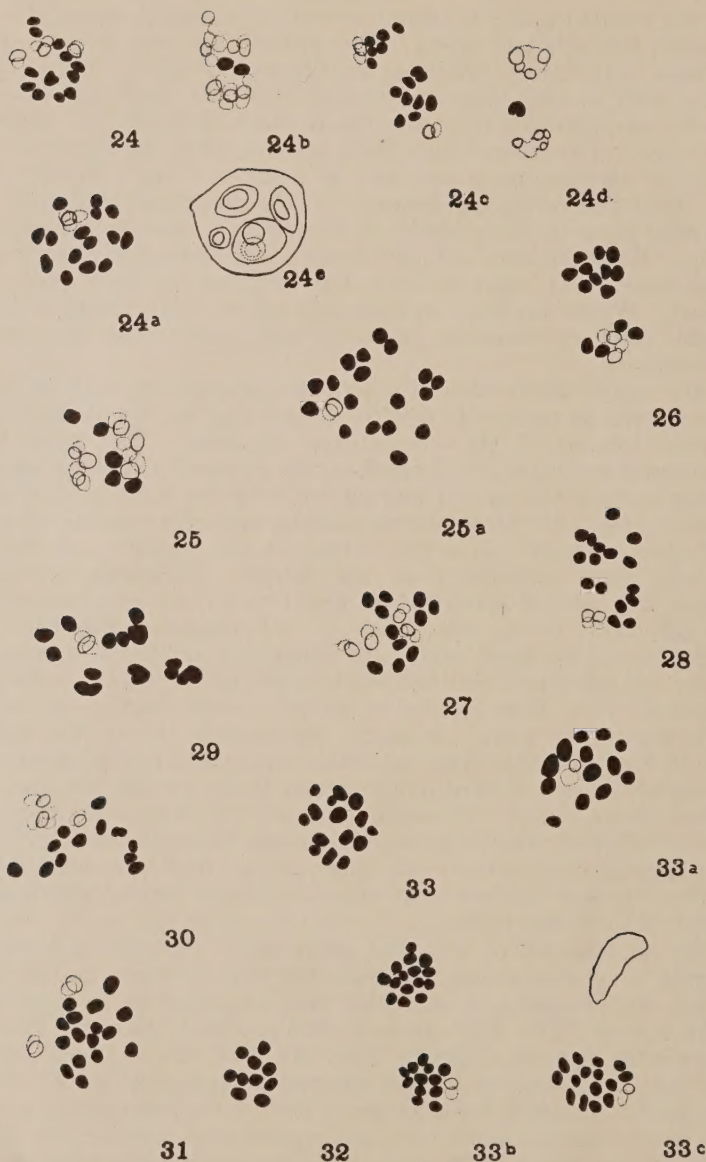
<sup>1</sup>Abbreviation—intermediate= int.<sup>2</sup>These plants died during the winter of 1933-34.<sup>3</sup>By 1937 only one dwarf plant remained and it did not bloom.

and as the plants came into bloom to make cytological examination, to see if more triploids had arisen. The latter study was commenced in 1934 when only fifteen seedlings had flowering stalks. It was continued in 1937 and by that time though thirty-six seedlings of plant 7 had been transplanted, only one dwarf plant of these had survived. Records kept of the population show that in 1935 the plot had been depleted to twenty-one plants and in 1936 to "eight mostly small plants," with one producing flowers. As the dwarf plant did not come into flower, none of the progeny of this triploid were examined cytologically. From the large number of others, an almost random sampling was necessary. At least one of the progeny of each plant was examined. Where variation in unusually tall or small plants or of any noticeable phyllary character appeared, such plants were also selected for examination.

In the early examination of one of the progeny of plant 12, which was considered as typical *L. ligulistylis* (see Fig. 4), IM showed many univalents instead of the normal ten bivalents. The same plant was examined several times to check on the possibility of some temporal condition causing the lack of pairing but only the same kind of figure was found (Figs. 24, 24a). From examination of a number of slides, one bivalent appeared as a ring tetrad at the equator and eighteen univalents were scattered over the spindle. Following through I anaphase (Fig. 24b) it seemed there might be a fairly even distribution of the univalents to the two poles. In a I telophase (Fig. 24c), nine were already at one pole while nine others lay scattered between the plate and the other pole with the one bivalent in the process of dividing. Disjunction of its diads seemed to follow the distribution of the univalents toward the poles. A single chromosome left on the spindle, as seen in Fig. 24d, might have been the result of its belated separation. Late second division showed many regular pollen tetrads but also some with five or six nuclei. In one microsporocyte (Fig. 24e) there were five cells; two very small ones as might come from the extra spindle of such a lagging chromosome, one large cell as might be formed by a restitution nuclear process after one incomplete second division and two cells of the normal size.

After examination of a second plant which showed complete lack of pairing of chromosomes, without even one bivalent at IM (Figs. 25, 25a), all the plants of that plot were examined at the expense of time for others. The third one examined proved to have ten bivalents and perfectly regular divisions (Fig. 26). Of the eighteen progeny of this plant 12, two more showed complete asynapsis (Figs. 27, 28).

By scatter sampling it was hoped to learn if the progeny of any other plants would likewise show both the regular and asynaptic condition. As two of the plants of A were found with complete asynapsis, an effort was made to examine all of that plot. In nine others there was regular conjugation and one was a near triploid (Fig. 29). Of other plots it was possible to examine only a few each. In two of these (8 and S), of which only a limited number were examined, a seedling of each showed the same complete asynapsis (Figs. 30, 31, respectively), while another had 10II (Fig. 32). In the progeny of 12 of the 17 plants, only bivalents were found, although unfortunately but one or two of



FIGS. 24-33. IM and IIM of progeny of plants. FIG. 24. 12 plant. 32. 24 and 24a. IM. 24b. I anaphase. 24c and d. I telophase. 24e. Microsporocyte (ca 600 mag.). FIG. 25 and 25a. IM 12 plant 7. FIG. 26. IIM 12 plant 2. FIG. 27. IM 12 plant 17. FIG. 28. I anaphase 12 plant 36. FIG. 29. IM A plant 26. FIG. 30. IM 8 plant 33. FIG. 31. IM S plant 7. FIG. 32. IM S plant 10. FIG. 33. Z plant 13. 33 and 33a. IM. 33b and c. IIM.

FIGS. 20-23. Mitotic chromosomes as seen in root-tips from seeds, fixed in Karpechenko's fluid, sectioned and stained in Newton's Gentian Violet, shown at approximately 1400 mag. FIG. 20. Plant X. FIGS. 21, 22, 23. From three seeds of plant 7, respectively.

each were examined. In the progeny of 4 plants, asynaptic behavior was found as shown in Table 2B. In summary, regular division of 10II was found in 42 or 80% of a total of 52 plants studied and asynapsis in 8 plants.

In one of the progeny each of the two plants A and Z, there were repetitions of the divisions seen in the triploid plant 7. Some of the IM chromosome counts were 15 to 17. In cells of plant Z (Figs. 33, 33a) it was clear that larger and smaller units were intermingled. In IIM plates it was possible to see that sometimes there was an almost even division of the units to the two daughter cells (Fig. 33b). In others, division seemed less regular, 17 units having been counted on one plate of a cell (Fig. 33c). Late second division telophases showed small chromatin remnants outlying and there were a variety of microspores. Irregular numbers and sizes of cells were seen, similar to those described for plant A having asynapsis.

Cytological examination in 1937 had included the largest plant in seven different plots as well as what had been the tallest plants of five different plots in 1936 without showing any further triploids. The largest plant of plot Z, which had also suggested some hybridity (see Fig. 4), did prove to be one of the triploids described. It was, however, the only one examined of that plot. Also the one other triploid discovered among the progeny in plot A (plant 26) had not been unusual in size. Thus, there was no evidence of correlation between greater size and triploidy though they had occurred jointly in the first triploid plant 7.

From seven of the progeny that had been studied the first season (1934) and set seed that autumn, seed was collected to be germinated for root-tips. These included four normal diploids and three asynaptic plants, the one from plot 8 and two from plot 12 representing the wholly asynaptic and the plant with but one bivalent (12 pl 3). It was noticeable that the latter three were almost completely sterile, yielding respectively only three, two and fourteen filled achenes. A single root-tip from one of the germinated seeds of the latter showed numerous fragment-like chromosomes. By contrast in a tip from a seed of one of the same plot that had shown ten bivalents (12 pl 2) 20 somatic chromosomes were found.

#### DISCUSSION

In a plot of eighteen seedlings grown to be a help in determining the specific identity of an accession of two diploid *Liastris* plants ( $2n=20$ ), having normal meiosis, one proved to be a near triploid. In this plant usually there were only slightly fewer than ten bivalents, along with a varying number of univalents at IM. In some cells the various configurations of bi- and univalents closely approximated the triploid complement of 10II and 10I. Though this one variant was a vigorous plant, attaining in comparison with the other diploid plants the top figures in height and floral characters (see Table 1), it was very like typical *L. ligulistylis*. In none of the characters of leaf and phyllary size and shape and number of florets was there any recognizable evidence of hybridity, as seemed possibly so in at least two other seedlings (S and Z).

As a result of open pollination, achene development in this triploid was estimated as at least fifty percent. Germination of its achenes, tested in two seasons, also was surprisingly good, at least 70%. Thus, the unbalanced chromosome condition did not have too harmful an effect on achene formation or viability. However, eventually it proved deleterious for it was the only plant of which no seedlings had survived in the plot to the third season to produce flowering stalks.

Thus, cytological examinations could include only the progenies of the diploid plants. Of a total of 22 plants studied, 7 showed complete asynapsis of chromosomes at IM and one had but a single bivalent with eighteen univalents. Not enough of the progeny were examined of any plants except numbers 12 and A, to make the over-all figures significant as to percentage. However, all of the seedlings in bloom of No. 12 were examined with 4 of 18 showing complete or nearly complete asynapsis. That proportion is not too remote from a strict Mendelian ratio of 1:4 if asynapsis occurred as the result of a recessive gene in this plant. Though not quite the complete population of plant A was examined, 2 of the 12 examined showed complete asynapsis, with one other a near triploid. Also in the scatter sampling of nineteen of the progeny of eleven other plants asynapsis was found once in a plant of No. 8. Thus, there is evidence for some cause affecting asynapsis of chromosomes in this population. As plants 12 (Fig. 9), A (Fig. 8) and 8 like the original plant X (Fig. 1) appeared to be true *L. ligulistylis*, with no hybrid evidence, it seems possible that such chromosome behavior may be due to a recessive gene as it was cytologically proved to be in maize by Beadle.

The meiotic figures are strikingly like those shown by Beadle (1930). The general lack of bivalents is similar to those he found in maize stating "Twenty univalents are most often present. One bivalent and eighteen univalents are less frequent. Figures with more bivalents are less often observed." In this population of *Liatris*, asynapsis was complete for all the plants in which it was found except one and in it only one bivalent occurred with eighteen univalents. Similar too to the condition in maize was the almost complete sterility of at least three of the asynaptic plants for which records were taken. In maize it had been stated that the asynaptic plants were distinguishable in the field from normal sibs by their sterile nature.

Of further significance and similarity to the condition in maize may be the sporadic occurrence of triploidy in this population. When asynaptic plants of maize were crossed by normal, triploids were suspected though they were discovered too late to be examined cytologically. However, their progenies, produced by self-fertilization, had chromosome numbers varying from 20 to 36 as might be expected to result from triploid plants. Also since it was known that an unbalanced chromosome condition resulted in poor endosperm developments, kernels of plants produced from the cross asynaptic by normal were classified relatively as good or poor. From somatic counts made in root-tips from well and poorly developed kernels, the former were found to be associated with diploid and the latter with triploid embryos. This gave evidence that some female gametes with the unreduced chromosome number in the asynaptic plants gave rise to triploids. The

parent plant of the first triploid *Liatris* plant 7 was not seen as it had been grown from seed. However, among the progeny of eighteen plants grown from the same packet of seed, triploidy appeared in two of fifty-two examined. A large number proved to be asynaptic giving similar evidence of microspores with unbalanced chromosome complements. The occasional triploids could have arisen, as in maize, from the unreduced female gametes of an asynaptic plant and the pollen of a normal. Among the progeny of plant A, two asynaptic and one triploid were found. Though the comparative fertility of these two was not tested, as stated above, three asynaptic plants had been found to be practically sterile. Also, though achenes of the first triploid plant 7 had been quite viable, there was an unusually high mortality of the seedling plants. This suggests the possibility of some deleterious factor in both the asynaptic and triploid plants; it might even suggest a similar lethal effect in both.

More frequently the origin of triploids has been associated with hybridity. Peto (1934), out of twelve plants examined of the supposed natural hybrids between *Festuca pratensis* ( $n=7$ ) and *Lolium perenne* ( $n=7$ ), found two that were triploids. Although other natural hybrids of *Liatris*, as  $\times L. Weaveri$  Shinnery and  $\times L. creditonensis$  Gaiser (1951a and 1951b) had been studied cytologically, no evidence of the triploid condition had been found. Indeed in my studies of *Liatris* no triploids of any species had been found to occur in nature. Thus, for the origin of the first one the question of its hybridity was considered. As the photographs and table of characters show, plant 7 was not of recognizable hybrid phenotype and varied little from true *L. ligulistylis* except that it was more robust. It was seen that, in contrast, two other plants S and Z did give evidence of some hybridity. Their tall, slender, spike-like inflorescences and rounded phyllaries with entire margins were suggestive of the characters of some other species, possibly *L. spicata*, a species commonly found in nurseries. But the three plants 12, A and 8, which gave rise to the asynaptic plants, were also typical *L. ligulistylis*. Thus, like them, the triploid seemed to have had only genomes of one parent species. It may be assumed that if a recessive gene for asynapsis prevents pairing in a diploid plant homozygous for that gene, then the heterozygosity and change in dosage relations occurring in the presence of a third chromosome set might result in a triploid with some pairing. The cytological figures of plant 7 support this assumption. A triploid arising from an asynaptic diploid would have chromosome configurations scarcely distinguishable from those of a species hybrid unless the chromosomes of its parents were of different size. The figures in the one triploid plant of Z studied, were so similar to those of 7 that it was not possible to say whether its origin might have been due to some hybridity of the parent or was another resultant of asynapsis. At least the maternal parent plant as also plant S, if they were hybrid, were known to have the diploid chromosome number (see Figs. 17, 18) and regular meiosis. Since there was at least slight morphological evidence for hybridity in two of the 16 seedlings, the possibility that the partially asynaptic triploids were derived from species hybrids cannot be excluded completely perhaps. On the other hand, they showed no morphological

evidence of hybridity and their behavior is well explained by a recessive gene for asynapsis.

Since the term asynapsis as originally defined by Randolph (1928), was used to express absence of any synapsis in the prophase of meiosis, Li, Pao and Li (1945)<sup>4</sup> have suggested the name desynapsis for unpaired chromosomes at IM due to a dissociation following an earlier synapsis. The term was applied by them to the condition in wheat where the cause was shown to be dependent upon environmental effects of temperature. In the study of *Liatris* an effort had been made to see if the results were altered by changes in temperature. Besides examining the same plant on days of high and lower temperature, several of the progeny of plant 12 had been examined on the same very cool days in late August and showed respectively all bivalents in plant 2 and all univalents in plant 7. Also since the same plant 17, checked in the two seasons 1934 and 1937, always showed asynapsis, it did not seem to be correlated with environmental changes. Having no evidence that there had been any synapsis in early prophase stages preceding this irregular behavior, the term asynaptic has been used in the above discussion, in the sense of unpaired chromosomes at IM as in the cases of *Zea Mays* (Beadle, 1930, 1933), *Datura* (Bergner, Cartledge, and Blakeslee, 1934), *Nicotiana* (Goodspeed and Avery, 1939), and *Oenothera* (Catchside, 1939).

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## Quercus oglethorpensis—Range Extensions and Phylogenetic Relationships

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This tree was described in 1940 (Duncan, Amer. Midl. Nat. 24: 755-756) and its distribution given as Wilkes, Elbert, and Oglethorpe Counties, Georgia. One collection is cited for each county, the location in the first county being in doubt and perhaps even identical to that in Oglethorpe County (the type locality) because of its proximity to Wilkes County. The Elbert County station is about 22 miles due N. E. of the type locality. Since publication of these data, this species has been seen in many places until its known distribution in Georgia now includes an area about 25 miles long and 10 miles across the north-eastern portion (Fig. 1).

Of greater significance than these range extensions in Georgia, however, is the discovery of this species in South Carolina. During the war Prof. G. N. Bishop of the University of Georgia, School of Forestry, who was temporarily stationed in South Carolina, observed this tree growing in Greenwood County.

On 26 October, 1946, he accompanied me on a field trip to see the tree at this station. We had just crossed Cuffytown Creek in McCormick County, S. C., on the main highway about 7 miles east of McCormick when I saw the striking red leaves of *Q. oglethorpensis* some distance from the roadside. A short trip was made out through the broad bottomland and many trees of the species were seen and a collection made (Duncan 7373). We then drove up to the Greenwood County station that Professor Bishop had located earlier. This location is near Beaverdam Creek, a small tributary of Cuffytown Creek.

Later in the same day two more stations were located in Greenwood County, bottomland of Horsepen Creek at Kirksey, 13 miles S.S.E. of Greenwood, Duncan 7374; and bottomland of Hardy Creek about 15 miles E.S.E. of Greenwood and 8 miles S.S.E. of Ninety-six, Duncan 7376. The latter station is in the Saluda River drainage system and is the first time this tree was known to occur outside of the Savannah River drainage system.

We planned to explore farther that part of South Carolina and determine the distribution more accurately. These plans never materialized. During 1949, however, I visited the area in connection with an extensive vegetative survey of the upper part of the Savannah River Valley\* and additional stations were found. The species occurs in Edgefield County (Duncan 10605. 8 Oct. Open woods along Cyper Creek, 12.5 miles W. 20° N. of Edgefield), McCormick County (Duncan 10612. 8 Oct. Open woods in level area near Wine Creek

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10 miles S. 62° E. of McCormick—one tree is 74 cm. in diam., 14 cm. larger than reported previously), and Saluda County (*Duncan 10625*. 9 Oct. "Flatwoods" about 10 miles W.N.W. of Saluda). Also, several trees were seen a few miles south of Ninety-six. The distribution for South Carolina may be seen in Figure 1. Considerable effort was made to locate the species outside the limits established by these collections and observations but no stations were found.

It seems important that the species occupies the same type of habitat in the geologically old Piedmont Province of both states. The area occupied is mostly quite level land along streams. Most of these areas are rarely flooded by overflow of the streams but after heavy rains are frequently occupied by small to large pools of water which drain away slowly because of the levelness of the areas and the nature

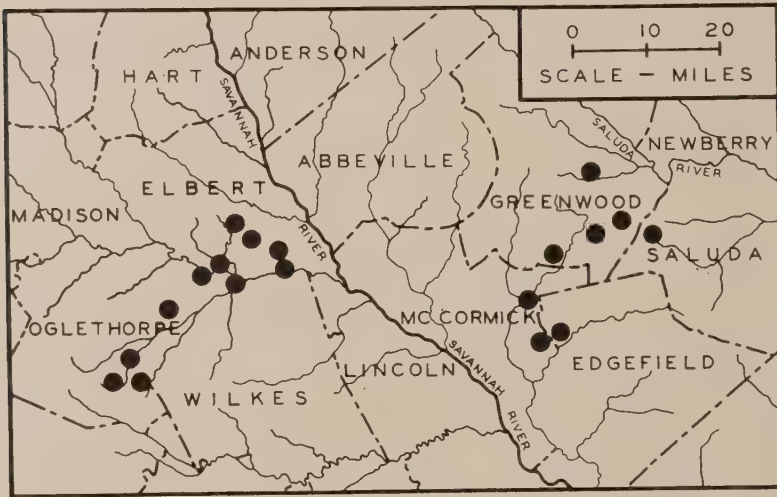


FIG. 1. Portions of Georgia and South Carolina, separated by the Savannah River. The known distribution of *Quercus oglethorpensis* is indicated by dots.

of the soil which is relatively impervious to water and which upon wetting forms a sticky, gummy, greyish mass. The water retained in the pools usually becomes clouded. Occasionally the oak is found on the gentle slopes adjacent to the bottomlands or on level upland areas nearby. Here the character of the soil is the same. It is only rarely that the tree occurs in the alluvial soil which was reported earlier (*Journal of Forestry* 39: 1941) as being the soil type usually occupied by the oak. Although reproduction is abundant the oak seems to be unable to spread beyond the habitats described.

The general area occupied by the oak in both states is characterized by the general absence of any appreciable relief. It is more nearly level than most of the piedmont. In addition the level areas along the streams are very broad in relation to the size of the streams. Erosion apparently reached a local base level a great many years ago. After it occurred to me that the specific type of area occupied by *Q. ogle-*

*thorpensis* is probably old geologically, I began to wonder whether or not *Q. oglethorpensis* might be a relic; and, if so, what the related species and their phylogenetic relationships might be.

A detailed analysis is not possible at this time (such an analysis would require careful monographic work). A general survey, however, yielded evidence from which a fairly clear evolutionary picture emerged. Although of restricted distribution because of habitat requirements, *Q. oglethorpensis* is probably a relic. Primitive characters are exhibited in the entire leaves and the thin scales of the acorn cup, no relatives have similar leaf shape, and the area occupied is very old geologically. Related oaks are: *Q. breviloba* Sarg. (*Q. annulata* Buckl.), *Q. durandii* Buckl., *Q. austrina* Small, *Q. margaretta* Ashe, *Q. chapmani* Sarg., *Q. stellata* Wagenh., and *Q. alba* L.\* The contention that they are related is based particularly on characters of bark and acorn cup, on relative ecological requirements, and on considerations of distribution in relation to geological factors.

In general those listed first are more closely related to *Q. oglethorpensis* and those listed last are less closely related. A phylogenetic tree was constructed (Fig. 2). All species have bark with small, loose, grey flakes, those species on the uppermost part of the tree having a tendency to have slightly coarser flakes. Leaf lobing is generally least on the lower part of the tree (usually absent in *Q. oglethorpensis*) and greatest on the upper part. Variation in the populations is greatest, and evolution apparently most active, on the upper branches, especially in *Q. margaretta*, *Q. alba*, and *Q. stellata*. The last two species have a wide distribution in the eastern United States.

The three species on the major limb to the right are found almost exclusively in well drained soils while the three species on the major limb to the left are found most often in mesic habitats.

It also seems important that the species on the lower limbs occupy, or are more nearly restricted to, areas that are older geologically than the areas occupied by those on the upper limbs. Palmer (Amer. Midl. Nat. 33: 514-519, 1945) in discussing *Q. durandii*, *Q. austrina*, and *Q. breviloba* suggests that *Q. durandii* is a relic. As supporting evidence he offers its wide and interrupted distribution (mostly in the Coastal Plain from Texas to Georgia and Florida) and restriction to definite ecological areas. This contention probably holds relative to *Q. austrina* which is less restricted to definite ecological areas (in the Coastal Plain from Mississippi to upper Florida and along the coast in Georgia). Following the same criteria, it would seem that a still older relic would be even more restricted in its distribution, because as time elapsed outpost after outpost would be eliminated. Furthermore, an older relic is likely to be more restricted ecologically and probably occupy areas that are relatively older geologically. This appears to be true of *Q. oglethorpensis* and *Q. breviloba*. Palmer, however, does not point out this possibility for *Q. breviloba*, but merely states that it occurs on limestone hills near Austin, Texas, ranging westward through the Edwards Plateau to Devils River, and also in the Arbuckle Mountains of Okla-

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\*NOTE: No significance should be attached to the use of species names for all of these entities. Sufficient studies were not made to enable determination of the status of each.

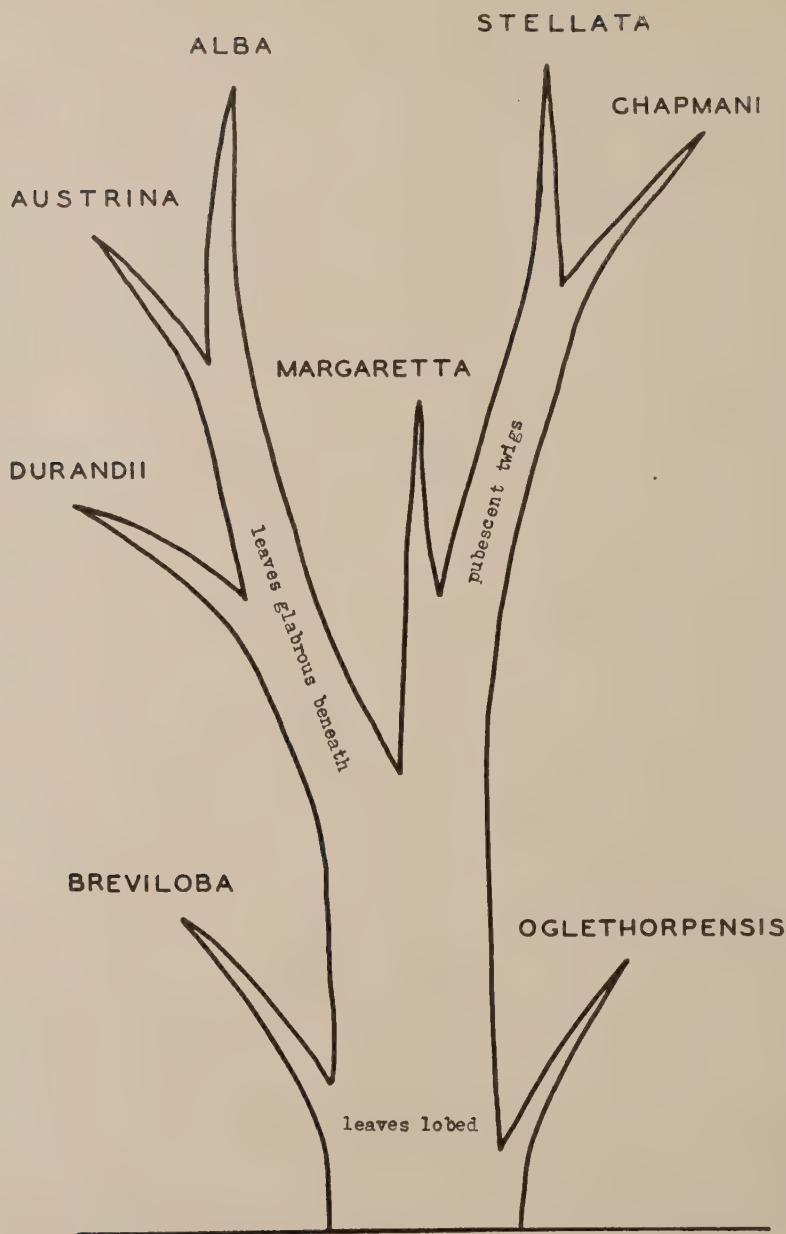


FIG. 2. Phylogenetic tree of a group of related species of *Quercus*.

homa. These areas are much older geologically than that occupied by *Q. durandii*.

It is thought that the primitive ancestor of these eight oaks had bark with small, loose, grey flakes; glabrous twigs; and leaves with entire margins and pubescent beneath. This ancestor would be more similar to *Q. oglethorpensis* than to *Q. breviloba*. Both have leaves pubescent beneath. As *Q. durandii* evolved, lobing became more pronounced and the pubescence disappeared except on young leaves. *Q. alba* appears to be the most recent species evolved from this line. When I have observed *Q. austrina* at a short distance in the field, its similarity to *Q. alba* in bark, general leaf appearance, and crown shape has been striking to me. Admittedly in *Q. alba* the acorn differs some and the acorn cup differs considerably from those in *Q. austrina*. Both species, however, have closely similar ecological requirements where their ranges coincide. Consequently, *Q. alba* is considered as being not far removed phylogenetically from *Q. austrina*.

On the major limb to the right the first species evolved was *Q. margaretta* which occurs from Arkansas and Texas to Central Florida and southeastern Virginia. This species is common in sandy soils of the Coastal Plain. It also occurs on the Eocene sand hills along the Fall Line, and in the Piedmont (of Georgia) on well drained sandy terraces along streams and in sandy soil at margins of flat granite outcrops. It probably has occupied these last three habitats for a considerable number of years and may be an even older relic than *Q. durandii* which is mostly confined to the younger Coastal Plain.

*Q. stellata* and *Q. chapmani*, likewise developed on this major limb to the right, the principal difference being the development (or acquisition?) of pubescent twigs. *Q. chapmani* is much less lobed than *Q. stellata* and *Q. margaretta* (which are similarly lobed); in fact they are so much less lobed they suggest a more primitive position. *Q. chapmani*, however, is abundant on recently formed land areas (often islands) along the coast of South Carolina, Georgia, and Florida, extending inland on peninsular Florida. This distribution suggests such a recent origin that *Q. chapmani* is placed near the top of the evolutionary picture. Further evidence of the close relationship of *Q. margaretta*, *Q. chapmani*, and *Q. stellata* is found in the fact that the first two species are limited to well drained sandy soils, and the same soil is frequently present in the habitat of the latter species (which also occurs on loam and clay soils).

Other species such as *Q. virginiana* and *Q. lyrata* Walt. may be part of the evolutionary picture just presented for the eight species. In regard to the first species the similarity of twig pubescence to that of *Q. stellata* and the similarity of certain aspects of the acorn cup to those of several of the eight species seem important. In *Q. lyrata* the character of the bark is like that of the eight species, the leaf pubescence and certain aspects of lobing resemble those of *Q. stellata*, and the moist habitat and general appearance of lobing indicate affinities with *Q. alba*. I am aware of little other evidence supporting these last contentions. It will serve, however, to indicate to the reader that the evolutionary picture presented in this paper may not be complete, especially since some chimera grafts may have occurred on the phylogenetic tree.

## SUMMARY

The known range in Georgia of *Q. oglethorpensis* now covers an area 25 miles long and 10 miles wide at the northeastern end.

This species is reported for South Carolina for the first time, where it occurs in four counties over an area about 25 miles long and 10 miles wide at the northeastern end.

This study is not a detailed analysis but a general survey providing evidence for a fairly clear evolutionary picture.

Apparently the area occupied by *Q. oglethorpensis* is geologically old. This suggests the possibility that this oak is a relic. Morphological affinities with seven related oaks, comparative ecological requirements of all eight species, and considerations of distribution and geological age of the areas occupied by the species support the contention that *Q. oglethorpensis* is a relic species.

A phylogenetic tree for the eight species is presented and the data upon which their relative positions were determined are given.

# Supplementary Notes on the Genera *Campanella* and *Favolaschia*

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In a previous paper<sup>1</sup> the author treated the genera referred to the *Laschia*-complex, i.e., all basidiomycetous fungi then lumped together and confused with the two genera *Laschia* existing in the literature. He demonstrated that the original genera are synonyms or homonyms, respectively, while some of the homobasidial genera confused with *Laschia* Fr. are agarics. Others show affinity with certain elements of the heterogeneous group called Cyphellaceae (more precisely with those that are close to *Leptotus*) and definite similarities with certain species of the genus *Aleurodiscus*. These similarities may well reflect affinity. The species studied in order to illustrate the generic systematics of the *Laschia*-complex were described and keyed out.

Meanwhile, more material has been sent to the author and collected by himself in Florida and in South America, especially of the genera *Campanella* and *Favolaschia*. Since no monographic paper has appeared, the determination of these striking little fungi is almost impossible for those who have not specialized in the group, and have no types at their disposal. To overcome this difficulty additional descriptions of species belonging to these genera and emended keys are here provided.

## Genus CAMPANELLA

- A. Cystidia none.
  - B. Spores small, not longer than 7.6  $\mu$ .
    - C. Carpophores white to yellowish, turning purple. . . . . *C. caerulescens*
    - C. Carpophores brown. . . . . *C. floridana*
  - B. Spores large (longer than 7.6  $\mu$ ).
    - D. Spores (9) 11–13.5  $\mu$  long. . . . . *C. agaricina*
    - D. Spores 7.7–10  $\mu$  long.
      - E. Spores 8.5–10  $\mu$  long, extremely inequilateral. . . . . *C. alba*
      - E. Spores 7.7–9  $\mu$  long, normally and evenly ellipsoid,
        - C. Junghuhnii*
  - A. Cystidia present<sup>2</sup>. . . . . *C. simulans*

*CAMPANELLA CAERULESCENS* (Berk. & Curt.) Sing., see Lloydia, l.c., p. 190.

***C. floridana*** Sing. spec. nov. Carpophoris pendulis e basi fortissime gelatinosa, pileatis e cupuliformi-pendulis ostreatis, demum lobato-flabelliformibus; superficie sterili brunneo-fusca ("Stag," dein "olive wood," dein "Mandalay" Maerz & Paul), obscurius reticulata et

<sup>1</sup>Singer, R. The *Laschia* Complex (Basidiomycetes). Lloydia **8**: 170–230. 1945.

<sup>2</sup>The following species are also said to have cystidia: *Campanella merulioides* (Heim) = *Laschia merulioides* Heim, Rev. Mycol. **10**: 48. 1945; (1946); *Campanella Eberhardtii* (Pat.) Sing.; *C. candida* (A. L. Smith) Sing. (as for the latter two species see Lloydia **8**: 170–230. 1945).

reticulationibus deum depressis, glabra, usque ad 28 x 12 mm. — Hymenophoro concolori, primus e venis lamelliformibus paucis (usque ad septem) consistentibus quae inter se reticulariter anastomosant, dein anastomosis circiter medium altitudinis venarum approximantibus et nonnullis "lamellis" inter venas primarias ortis. — Stipite vero nullo; base gelatinosissima, suncommuni, concolori. — Carne subconcolori, gelatinosa, subgummosa; sapore miti; odore nullo. — Sporis 5.3–6.2 x 4.4–5.1  $\mu$ , subglobosis vel breviter ellipsoideis, levibus, hyalinis; basidiis tetrasporis, clavatis, 23–28 x 7.5–8.5  $\mu$ ; cystidiis nullis; tramate ex hyphis tenuibus, tenuitunicatis, hyalinis, in massa gelatinosa immersis consistente; hyphis cuticulae densius dispositis (haud gelatinosis), intermixtis, tenuibus et ramificationibus nodisque brevibus ornatis (structuram *Variarum* valde depauperatam efformantibus). — Ad truncum vetustum *Magnoliae grandiflorae* in dumeto subtropicali gregatim et subaggregate crescentes. U. S. A.: Newnan's Lake, Florida. July 31, 1947, Leg. *R. Singer* no. *F 3428* (typus, FH).

This species differs clearly from the closely related species, especially *C. caerulescens*. I compared the types of this and all other species allegedly belonging to the same species according to Lloyd, but none of them is identical with my Florida material. I have not, however, compared *L. Curtisii* which according to Lloyd is a mixed collection and does not belong here because of the description of the pores. I have been unable to compare *L. Dussii* Pat. which is said to have larger spores than the Florida species.

The fresh material gave no remarkable chemical reactions. Phenol causes a slight darkening of the surfaces.

CAMPANELLA AGARICINA (Mont.) Lloyd, Mycol. Writ. 5:816. 1919.

*Exidia agaricina* Mont. ex Mont. in Gay, Hist. Chile 7:392. 1850.

*Laschia agaricina* Pat., Journ. Botan. 1:228. 1887 (sed det. errone.)

Carpophores pendulous and cupuliform, at first like *Cyphellas*, later less cupulate and relatively lower, more repand; sterile surface white when quite fresh and humid, when drying first cream color and then orange ("Dorado" Maerz & Paul), glabrous, neither sulcate nor pustulate, convex-campanulate, 5–10 mm. broad, mostly about 9 mm. — Hymenophore consisting of lamellate veins (0.5 mm. broad) which run radiately from an eccentric or centrally umbilicate point towards the margin, the "lamellae" distant and crisp, irregularly connected by numerous anastomosing and forking lines or veins which are from lower to equal (to the "lamellae") in breadth; sometimes also a few venose "lamellulae" present, white, soon cream color, upon drying reaching "Gold leaf" in a marginal zone, but the larger central zone becomes yellow (Pl. 12, I–11, M & P.). Stipe absent in my collections. Context concolorous or paler than the surface, thin, gelatinous, inodorous.

Spores hyaline, the whole inner side flattened or with a small suprahilar depression, otherwise oblong-ellipsoid, smooth, nonamyloid, thin-walled, (9)–11–13.5 x (4)–4.8–5.3  $\mu$ ; basidia (2)–3–(4)-spored, clavate, hyaline, forming a continuous hymenium, unicellular to the end, with acrogenous sterigmata, 33–35.7 x 6.5–9  $\mu$ ; basidioles cylindric-filamentous, transforming themselves in their further development

either into basidia or into pseudoparaphyses (in this case remaining morphologically unchanged) or into pseudoparaphyses which differ from the pseudoparaphyses in forming some nodules and side-branchlets; all these bodies hyaline and non-amyloid; true cystidia of the type observed in *C. simulans*, absent; hyphae of the trama hyaline, imbedded in a gelatinous mass, thin and filamentous, loosely arranged, with clamp connections, non-amyloid; hyphae of the sterile surface thin, dense, often branched, rather rigid, the branchlets appearing under a right angle in a large number of ramifications (this is a slightly modified *Asterostromella*-structure).

On wood of *Alnus jorullensis* var. *Spachii* in the montane zone of the rain forest, fruiting all spring and summer, but scattered, collected Nov. 14, 1949, in the Sierra de San Javier, and the Quebradita near Tafi del Valle, province of Tucumán, R. Argentina, *R. Singer* (T 774, LIL).

This is much closer geographically as well as according to the description, to the original *Exidia agaricina* Mont. than the interpretation suggested by Patouillard and Rick. I feel quite certain that this is either fully identical with Montagne's type, or at least a three-spored form of it.

C. ALBA (Berk. & Curt.) Sing., see Lloydia, l.c., p. 191.

C. JUNGHUHNII (Mont.) Sing., see Lloydia, l.c., p. 192.

C. SIMULANS (Pat.) Sing., see Lloydia, l.c., p. 194.

#### Genus FAVOLASCHIA

- A. Gloeocystidia not (or poorly) differentiated.
- B. Dendrophyses not distinct, i.e., erect sterile bodies covering the whole or parts of the pore edges or of the sterile surface are absent.
  - C. Carpophore decidedly red, and remaining so in the herbarium if properly dried.....*F. rubra*
  - C. Carpophores not red.
    - D. Surface of the pileus characterized by a poorly or well developed layer of dichophyses, forming a typical or depauperate *Asterostromella*-structure, or by irregular hyphae and pseudophyses, or by a superposed layer of conidiophorous hyphae; spores  $5\ \mu$  broad or broader.
      - E. Cystidioid pseudophyses either none or scarce; spores  $8.8\text{--}12.5 \times 7\text{--}9.5\ \mu$ .....*F. tonkinensis*
      - E. Cystidioid pseudophyses often forming hymeniform layers of some extension near the margin of the carpophores; spores  $6.5\text{--}10 \times 5\text{--}7\ \mu$ .....*F. pustulosa*
    - D. Surface of the pileus characterized by repent hyphae which are warty-diverticulate like the hyphae of the epicutis of *Mycena*. Spores  $5.5\ \mu$  broad, or narrower.
      - F. Carpophores cup-shaped, like a sessile *Helotium*, yellowish when dried.....*F. pezizaeformis*
      - F. Carpophores attached laterally with or without a short oblique stipe, vinaceous when dried, or, at least, not yellowish.....*F. minima*
- B. Dendrophyses rather distinct, well developed (see "J").
- A. Gloeocystidia large or broad, prominent and numerous, or at least gloeocystidioid bodies present which may or may not turn deep blue in cresyl blue mounts (use herbarium material at least several months old to demonstrate).

- G. Dendrophyses none; gloecystidia smooth.
  - H. Spores 6-6.8 x 4.5-5.5  $\mu$ ; sterile surface with *Asterostromella*-structure; stipe either short or inconsistent. . . . . *F. varariotecta*
  - H. Spores larger; surface structure not or not distinctly of the *Asterostromella*-type; stipe well developed and constant.
    - I. Spores 8-10 x 4-5.2  $\mu$ ; pileus up to 10 mm. broad. . . . *F. Puiggarii*
    - I. Spores 10.5-14.5 x 7-9.7  $\mu$ ; pileus usually larger. . . . *F. Sprucei*
- G. Dendrophyses present either on the edge of the pores or on the sterile surface, or—usually—on both.
  - J. Dendrophyses with an amyloid interior amorphous body, with long (2-3.6  $\mu$ ) spines, many of them with contents bluing in cresyl blue mounts; sterile surface avellaneous-brownish and pores white. On dicotyledonous plants in Argentina . . . . . *F. echinata*
  - J. Dendrophyses without amyloid bodies and fungi not combining the characters indicated above.
    - K. Carpophores white or pink or brownish, not red orange or yellow when young and fresh.
      - L. Carpophores white, not pink or brownish.
        - M. Gloecystidia bluing or not in cresyl blue mounts, smooth; dendrophyses always without contents; probably always on dicotyledonous plants. . . . . *F. pygmaea*
        - M. Gloecystidia bluing in cresyl blue mounts, echinate at least in their majority; dendrophyses without contents rare; surface bodies separating from the hyphae of the context, forming a sugary pulverulence. . . . . *F. saccharina*
      - L. Carpophores pink or brownish when quite young and fresh.
        - N. Sterile surface "Terrapin" (M&P), i.e., brownish; stipe well developed; carpophores 1.5-2 mm. in diameter when mature. On Pteridophyta. . . . . *F. pterigena*
        - N. Sterile surface "blush" or "Mindoro" (M&P), i.e., pink; stipe absent; pseudostipe sometimes present but very short and inconsistent. On Gymnospermae, but perhaps also on other hosts. . . . . *F. amoenerosea*
    - K. Carpophores bright yellow, orange, or red when fresh and young, later, in the herbarium, sometimes pallescent.
      - O. Pigment not localized in the gloecystidia.
        - P. Carpophores red and red when properly dried . . . . . *F. cinnabarina*
        - P. Carpophore yellow when dried, and yellow to orange when fresh.
          - Q. Gloecystidia large and striking. . . . *F. Gaillardii*
          - Q. Gloecystidia basidiomorphous and inconspicuous. . . . . *F. pezizoidea*
      - O. Pigment localized in the gloecystidia.
        - R. Carpophores distinctly pallescent when dried; spores (at least a large percentage of them) more than 5.2  $\mu$  broad. South American plants, growing constantly on Monocotyledones. . . . . (*Favolaschia Auriscalpium* group)
        - S. Basidia 4-spored; dendrophyses not cylindric . . . . . *F. flava*
        - S. Basidia 2-3-spored; dendrophyses cylindric . . . . . *F. sabalensis*
        - R. Carpophores not bleaching in the herbarium, or at least not bleaching to pallid whitish; spores in the South American race cylindric and not broader than 5.2  $\mu$ . . . . . *F. Thwaitesii*

Section 1. **Anechinus** Sing. sect. nov. Species dendrophysibus destitutae.

In this section we unite all species without dendrophyses since the latter organ seems to be more important and more constant in its presence or absence and its distinctive characters than the gloeocystidia. The type species of this section is *Favolaschia rubra* (Bres.) Pat.

*F. rubra* (Bres.) Pat., *F. tonkinensis* (Pat.) Sing., *F. pustulosa* (Jungh.) Sing., *F. pezizaeformis* (Berk. & Curt.) Sing., *F. minima* (Jungh.) Sing. see Lloydia 8: 196-201. 1945.

*F. VARARIOTECTA* Sing. See Lloydia l.c., p. 201. A third collection, also from Grenada, was located. It contained some specimens with rather long stipe; some of the branchlets of the dichophyses of the sterile surface are transformed into small dendrophyses which are ellipsoid-oblong; spores  $6.8 \times 4.8 \mu$ ; gloeocystidia numerous on the hymenium; hyphae with clamp connections; gloeo-vessels in the trama yellow, filamentous. On *Eulerpe* sp.

**F. Puiggarii** (Speg.) Sing. comb. nov.

*Favolus Puiggarii* Speg., Bol. Acad. Nac. Cienc. Córdoba 11: 452. 1889.

As for the macroscopical description no amendment can be made in regard to Spegazzini's original description as no fresh material has been collected since Puiggari's days. However, the type at La Plata (LPS) was analyzed and yielded the following data:

Spores  $8.2-9 \times 4-5 \mu$ , occasionally some smaller (but perhaps immature), and some slightly larger but not broader, distinctly amyloid, smooth, ellipsoid to subcylindrical; gloeocystidia numerous, below continued into gloeo-vessels, occurring in cystidioid form on the sterile surface as well as on the hymenophore, also on the surface of the stipe where they are broader, usually fusoid-clavate; dendrophyses none; trama distinctly gelatinous, its hyphae with clamp connections; many gloeo-vessels in the trama are not filled with cresyl-blue-absorbing contents.

This species is known only from Apiahy, Sao Paulo, Brazil. The type (no. 1443) has been divided by Spegazzini between his own herbarium and New York (NY). The affinities of *F. Puiggarii* are clearly expressed by its position in the key. It is very close to *F. Sprucei* but undoubtedly different even if the color were incorrectly indicated in the original description.

*F. SPRUCEI* (Berk.) Sing. Lloydia, l.c., p. 202.

Section **Polyechinus** Sing. sect. nov. Dendrophysibus praesentibus.

This section contains all the species with distinct dendrophyses. All, or practically all of them have some sort of pseudocystidia, color glands, or gloeocystidia, or gloeocystidioid bodies, mostly well differentiated gloeocystidia. The type species is *Favolaschia cinnabarina* (Berk. & Curt.) Pat.

*F. echinata* Sing. spec. nov. Carpophoris oblique subpendulis, lateraliter affixis, pseudostipitatis vel sessilibus. Superficie sterili subalbida, vel avellanea, sordidiore in vetustis (Pl. 12, G-6, or "fallow," or "oak buff" M&P), apparenter glabra sed siccando subfarinacea, a

pseudostipite (si exstat) haud differentiata, transparenter reticulata vel levi, 2–8 mm. lato.—Hymenophoro favoloideo, e poris angulosis saepeque irregulariter elongatis consistente; poris albis tactu aetateque superficiei sterili subconcoloribus (“Sombrero,” vel “Sunset” M&P), largis vel largissimis (0.5–1.0 mm. in diametro), usque ad septem pro carpophoro.—Stipite haud evoluta, sed pseudostipite base extracta formato saepe praesente.—Substantia subgelatinosa, inodora.—Sporis 9.5–12.3 x 8–10.2  $\mu$ , forma variabilibus, globosis vel breviter ellipsoideis vel reniformibus, levibus amyloideis; basidiis 43–44 x 11–13.5  $\mu$ , tetrasporis, perpaucis bisporis, clavatis, interdum intus aureis, plerumque hyalinis; gloecystidiis 45 x 7–10.3  $\mu$ , e vasculis gloeiferis natis, sat numerosis sed “cresyl blue” ope haud constanter caerulescentibus, multis hyalinis vel lilaceis permanentibus, aliis corpusculis exiguis caeruleis gaudentibus, levibus; dendrophysibus in superficie sterili nec non ad aciem pororum numerosis, multis ex eis “cresyl blue” ope caerulescentibus (nigro-caeruleis), aliis hyalinis permanentibus, longe-echinatis (aculeis pyramidatis, tenuibus, 2–3.6  $\mu$  longis), omnibus iodi ope (solutione Melzeri) corpusculum lilacimum internum exhibentibus, 15–50 x 14–20.5  $\mu$ ; hyphis inamyloideis, moderate gelatinescentibus, fibulis haud observatis (sed possibiliter praesentibus); strato externo superficiei sterilis hyphis repentibus levibus vel leniter echinulatis vel ramulos clavatos superne echinulatos emittentibus consistente.—Ad ramos putrescentia delapsa Angiospermarum (praecipue *Boehmeriae caudatae*) gregatim in silva subtropicali tucumanensi. Typus prope Los Sosas, provincia de Tucuman, 19–I–1950, *R. Singer* no. *T 919* (LIL); co-typus Parque de Aconquija, Sierra de San Javier, provincia de Tucumán, 1–III–1949, *R. Singer* no. *T 168* (LIL).

This species is not uncommon in the “Selva Boliviano-Tucumana” and seems to prefer urticaceous hosts. It is unique in having the lilaceous body inside the dendrophyses when the latter are observed in the Melzer, and also because of its unusually long spines around the dendrophyses. The only Argentine species, or at any rate “Spegazzinian species” which has not been compared is *Laschia antarctica*. The description implies that this is a *Favolaschia* but the occurrence in the cold zone of the South, and the size of the spores exclude this species. Unfortunately no type is available for further study, and a thorough search of the host (*Berberis ilicifolia*) in Fireland has not yielded any specimens referable to Spegazzini’s species. Consequently, the species from Tucumán must be considered as new.

#### **F. pygmaea** (Speg.) Sing. comb. nov.

*Favolus pygmaeus* Speg., Bol. Acad. Nac. Cienc. Córdoba **11**: 453. 1889.

Carpophores peltate-resupinate to reniform and laterally attached, 2–5 mm. broad; sterile surface whitish, reticulate-pustulose, slightly convex, appearing glabrous when moist but subpulverulent when dry.—Hymenophore white, consisting of angular irregular pores of 0.5–1.2 mm. in diameter, some of them somewhat elongate, tubes rather deep.—Stipe none, but carpophores at times very slightly laterally extended.—Context gelatinous, inodorous.

Spores 6–11 x 3.8–9.4  $\mu$ , extremely variable in size, most frequently 8.8–9 x 5.2–6.8  $\mu$ , ellipsoid, smooth, amyloid, sometimes collapsing in

dried material, hyaline; basidia 26–29 x 6–6.5  $\mu$ , 4-spored, few 2-spored (and then sterigmata strongly elongate: up to 13.7  $\mu$  long); gloecystidia extremely variable, sometimes very scattered and inconspicuous and not turning blue in cresyl blue mounts (pseudocystidia), sometimes rather numerous and a majority compactly blue granulate in cresyl blue mounts, often arising from gloeo-vessels or oeriferous hyphae; dendrophyses numerous, subglobose to balloon-shaped and pedicellate, almost entirely covered with normal (i.e., about 1  $\mu$  long) spines, hyaline, violet in cresyl blue mounts and without amyloid or oily contents, numerous on the sterile surface, 17–32 x 13–27  $\mu$ ; hyphae of the gelatinous layer thin and filamentous, hyaline, 1.7–2.7–(5.5)  $\mu$  in diameter, occasionally one reaching and entering the hymenial layer.

On dead branches of dicotylenonous trees in the subtropical and subtropical-montane zone of Brazil and Argentina, fruiting in summer and fall.

Material studied: BRAZIL: Apiaty, Sao Paulo, *Puiggari* 1881, no. 1650 (type), LSP, N.Y.—ARGENTINA: Anta Muerta, Sierra de San Javier, provincia de Tucumán, *R. Singer*, 20-XII-1949, no. T 787 LIL.

This species is similar to *F. echinata* but differs in having dendrophyses with much lower spines. The host of the Tucumán collection could not be determined but may have been *Boehmeria* as in the preceding species.

*F. SACCHARINA* Pat., see *Lloydia*, l.c., p. 203.

***F. pterigena*** Sing. spec. nov. Carpophoris subreniformiter convexulis, stipite laterali verticali praeditis, minutis: 1.5–2 mm. in diametro. Superficie sterili dilute fuscidula (“terrapi” M&P), pustulato-verrucosa secundum depressiones pororum, glabra, margine lobata. Hymenophoro e poris subrotundis,  $\pm 0.5$  mm. diametri consistente, pauciporo (poris quatuor vel novem), albo, base (superficie tramatis “pilei” ad hymenium versa) superficiei sterili concolori.—Stipite brunneo (“burnt umber” M&P), 0.5–1 x 0.5 mm.—Substantia subnulla, moderate gelatinosa, inodora.—Sporis 8.8–11 x 4–6  $\mu$ , plerumque 9 x 4.8  $\mu$ , hyalinis, amyloideis, ellipsoideis; basidiis 1- vel 5-sporis, 31–34 x 9.5–9.7  $\mu$ ; gloecystidiis clavatis vel fusoideo-ventricosis apiculatisque, partim caerulescentibus “bleu de cresyl” ope, altera parte a basidiolis aegre discernendis, ex hyphis oleiferis vel perpaucis vasculis gloeiferis natis, intus granuloso-repletis basidiis vix maioribus; dendrophysibus contentu caerulescenti vel amyloidea destitutis, numerosis, in superficie sterili saepe melleis e membrana subtiliter colorata, versiformibus sed plerumque vesiculoso-saccatis, obpiriformibus, ad basin defibulatis, aculeis mediis vel longiusculis (1.2–2.5  $\mu$ ) abundanter obsitis, 27–5.8 x 11–22  $\mu$ ; hyphis tramatis moderate gelatinosis, fibulis haud visis sed possibiliter praesentibus; hyphis superficiei sterilis interdum diverticulatis aculeis minimis et dendrophysibus interspersis.—Ad Pteridophyta varia emortua in zona subtropicali-montana et montano-subalpina haud raro, 1100–2400 m. altitudinis. Fructificationes formantur Decembri et Januario mensibus (probabiliter per annum tempore calidiore) in Argentina Septentrionali. Typus: Sierra Muñoz, provincia de Tucumán, 13-I-1950, *R. Singer* T 862 LIL. Etiam in Sierra de San Javier observata.

This species is remarkable for its habitat and the occurrence of monosporous and pentasporous basidia. Its very small size and the presence of a stipe, together with the color, should distinguish it readily from other species of this section. Since the clamp connections are usually best demonstrated in the gelatinous layer, and since this is rather poorly developed in *F. pterigena*, at least in the comparatively young specimens available for study, I cannot tell whether or not the absence of clamp connections is a character of any importance or value in this case. *F. pterigena* is closest to the following species.

*F. AMOENEROSEA* (Henn.) Sing. em.

*Laschia amoenerosea* Henn., Hedwigia **43**: 202. 1904.

Carpophores reniform, sessile or indistinctly stipitate with a pseudo-stipe, attached by the sterile surface, 5–9 mm. in diameter; sterile surface pink ("blush" to "Mindoro" M&P), soon bleaching to whitish, subpapulose, glabrous.—Hymenophore consisting of white pores which are angular, often elongated, 0.7–1.5 mm. in diameter.—Stipe none.—Context very thin and slightly gelatinized, inodorous.

Spores 6.8–9 x 5.5–7.5  $\mu$ , amyloid, ellipsoid or short-ellipsoid, hyaline, deep blue inside in cresyl blue mounts; basidia 4-spored; gloeocystidia almost club-shaped to ventricose, apiculate, versiform, rising from oleiferous hyphae or gloeo-vessels, few stained deep blue in cresyl blue mounts, the others inconspicuous; dendrophyses 21–26 x 19–23  $\mu$ , balloon shaped, with 1.3–2  $\mu$  long spines; hyphae of the sterile surface somewhat echinulate at places, intermixed with dendrophyses; base of dendrophyses not clamped at the septum.

On branches of *Podocarpus Parlatorei* (and other plants), in large numbers, fruiting in summer (January) in Argentina and Brazil.

Material studied: ARGENTINA: Cerro Alto de Taficillo, Sierra de San Javier, province of Tucumán, *R. Singer*, January 6, 1950, no. T 814, LIL.

This species is easily recognizable if observed in the fresh stage in rainy weather and, in this case, does not need any microscopical analysis since it is the only one that is pink in fresh condition. Much more difficult is the determination in dried condition, and the choice of the proper name for this fungus. I am convinced that Hennings described this species under the name of *Laschia amonerosea*, but his specimens must have been immature. The spore measurements probably do not refer to anything belonging to his specimen since he must have been unable to find spores, and if he did find spores he described them wrongly as usual in his diagnoses. Lloyd, who indicates this species as a synonym of *Laschia reticulata* (which would have priority if identical), indicates that the latter is represented by a carpophore at Kew and that he did not make a microscopical analysis. Since the color of *Laschia reticulata* is indicated as white, it may just as well be any other species as, of all things, *F. amoenerosea* in the dry or dried stage. Unless a careful analysis (if such is possible with the very scanty material) shows that the microscopical data agree with those of our description, I shall give preference to Hennings' name even though the type of the latter has been lost. Whether or not this species always occurs on conifers cannot be stated with certainty. One population of those observed by me, did not seem to be very selective since

the mycelium (although mainly growing in the wood of dead branches of *Podocarpus*) passed over onto other substrata such as dead ferns, but merely at the fringes.

*F. CINNABARINA* (Berk. & Curt.) Pat., see *Lloydia*, 1. c., p. 204.

*F. GAILLARDII* (Pat.) Pat., *Lloydia*, 1. c., p. 206.

*F. PEZIZOIDEA* (Berk. & Curt.) Pat. apud Sing., see *Lloydia*, 1. c., p. 206.

***F. flava*** (Bres.) Sing. comb. nov.

*Laschia flava* Bres., *Hedwigia* **35**: 285. 1896.

Carpophores reniform, laterally stipitate, small, 0.8–5 mm. in diameter; sterile surface deep orange red ("Mandarin R.," "Brazil R.," "Moroccan," then bleaching to "Pheasant testaceous" M. & P.) becoming yellowish and then whitish in the herbarium, convex, macroscopically glabrous, reticulate according to the dissepiments of the pores, almost circular in outline but with an incision where the stipe is attached.—Hymenophore consisting of pores which are circular at first but soon become angular, often nearly hexagonal but usually little elongated, pallid with an orange shade, soon becoming yellowish inside, slightly more numerous in an average than in *F. sabalensis* (viz., 10–20), small but comparatively very large, up to 1 mm. deep.—Stipe lateral, filiform to slightly tapering upwards, concolorous with the pileus in the lower third, slightly paler above, sometimes absent, 0–4 x 0–0.8 mm.—Context paler than the surface, gelatinous, inodorous.

Spores 7–11 x 4.3–7.5  $\mu$ , mostly 8.5–9.5 x 6  $\mu$ , amyloid, hyaline, sometimes with yellowish contents (and then tending to become blue in cresyl blue mounts), smooth but occasionally with slight irregularities such as small depressions and hooks, ellipsoid to subglobose, more often ellipsoid; basidia 23 x 7.5–8.8  $\mu$ , 4-spored; gloecystidia with amorphous pigment bodies of a large size, mostly completely filled with these and strikingly orange, even in cresyl blue mounts when fresh or freshly dried, but as soon as the carpophores begin to bleach, the typical gloecystidial reaction is easily obtained, versiform and about as those of *F. sabalensis* in size, but in an average narrower, often continued into gloeo-vessels which, however, rarely become deep blue in cresyl blue mounts, smooth and often very short, almost vesiculose; dendrophyses, together with the gloecystidia, numerous on the sterile surfaces of pileus and stipe, and on the edges of the pores where they form tufts, hyaline, vesiculose to broadly clavate, echinate as in *F. sabalensis* but much broader than in that species, 30–35 x 13–15  $\mu$ , only in few carpophores there is a small minority of subcylindrical dendrophyses which remain inconspicuous; hyphae of the sterile surface not echinate nor showing a tendency to form dichophyses, non-amyloid, with clamp connections, thin and filamentous, loosely arranged and imbedded in a gelatinous mass below the thin surface layer, hyaline.

On monocotyledonous hosts, especially Palmae and Gramineae such as *Chusquea*, gregarious, common in many tropical and subtropical regions from Panamá to Venezuela and south to Brazil and northeastern Argentina, fruiting practically the year round.

Material studied: PANAMA: Rio Chiriquí Viejo, provincia de Chiriquí, 1800–2000 m. alt., *G. W. Martin*, July 8, 1935, no. 2342, FH.—1600–1800 m. alt., July 5, 1935, no. 2496a, FH, both collections probably on palm.—VENEZUELA: Coll. *Fendler*, det. *Berkeley* as "*comp. Laschia pezizaeformis* B. & C." and *Curtis* as "*Laschia pezizaeformis* B. & C." However, this is different from the type of *F. pezizaeformis*, and belongs undoubtedly here. FH.—BRAZIL: Serro Azul, Rio Grande do Sul, *J. Rick*, 1928, FH (probably on *Bambusa*).—ARGENTINA: Cataratas del Iguazú, Misiones, *Singer & Digilio*, November 22, 1949, no. M 28 LIL.—November 26, 1949, no. M 78, LIL (both on *Chusquea* sp.).

This species is closely related to *F. sabalensis* (Charles) Sing. It differs in the slightly more intense pigment in fresh specimens and in the gloeocystidia, in slightly smaller spores and tetrasporous basidia, and in vesiculose dendrophyses. The type of *F. flava* which used to be preserved in alcohol in Berlin is now lost and has never been restudied by anyone except Lloyd. Lloyd says it was "of the same size and stipe" (shape?) "as *Laschia auriscalpium* but the cristated cells" (dendrophyses) "shown in the drawing are of a different shape." Since *Laschia auriscalpium* of Lloyd's herbarium is obviously the same thing as *Favolaschia sabalensis* (Charles) Sing., we have here rather good proof that *Laschia flava* is the species described above inasmuch as my own material as well as the material collected by Rick comes from a region very close and floristically very similar to that of the type locality of *L. flava* (Blumenau, Santa Catarina). Besides, the smaller spores as indicated by Bresadola fit the species described above rather than *Favolaschia sabalensis*.

There is no doubt in my mind that *Laschia auriscalpium* Mont. originally described by Montagne from material collected by Leprieur in French Guyana is either one or the other of these species. In either case, it would replace one of the more recent names applied by Bresadola and Miss Charles. If the material preserved at Paris is still in good condition, it should be easy to demonstrate its identity with either *F. flava* or *F. sabalensis*. Until this is done, I prefer to use specific names with a more definite meaning, and use *E. auriscalpium* as a group designation (stirps *Auriscalpium*).

Another species with bisporous basidia, comparable in this regard with *F. sabalensis*, has been described recently by R. Heim as *F. Calocera* (Rev. Mycol. 10: 50 [1945] 1946) unfortunately without Latin diagnosis. It differs from *F. sabalensis* in having a different type of dendrophyses, with the spines limited to the apices.

## Studies in Florida Botany\*

### 3. The Orchids of Florida

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The following list gives the members of the family Orchidaceae which have so far been detected growing within the state of Florida. Their accepted binomials are utilized, and general extra-territorial distribution is also appended.

At present, eighty-six species and varietal forms of orchids are definitely known from our area. Three additional species have been ascribed to Florida by various authors, but no Floridian material has been examined by this writer, and their occurrence in the state is assumed to be rather dubious. These are *Goodyera pubescens* (Willd.) R. Br., *Goodyera repens* (L.) R. Br. var. *ophioides* Fern., and *Liparis liliifolia* (L.) L. C. Rich.

It is interesting to note the recent collection of a specimen of the Chinese and Indian *Dendrobium nobile* Ldl. in Fahakahatchee Swamp. This plant was apparently an escape from cultivation, since no members of the genus occur spontaneously in this hemisphere, and this species is commonly cultivated in greenhouses throughout the area.

1. *Basiphyllaea corallicola* (Small) Ames Sched. Orch. **7** (1924) 1.—Also in the Bahamas.
2. *Bletia purpurea* (Lam.) DC. Mém. Soc. Phys. & Hist. Nat. Genève **9**, i (1841) 97, 100.—Also in the West Indies, Mexico, and Central America.
3. *Brassia caudata* (L.) Ldl. in Bot. Reg. (1824) t. 832.—Also in the West Indies, Mexico, Central America, and northern South America.
4. *Calopogon barbatus* (Walt.) Ames Orch. **2** (1908) 272.—Also north to North Carolina, and west to Mississippi and Louisiana.
5. *Calopogon barbatus* (Walt.) Ames var. *multiflorus* (Ldl.) Corr. in Bot. Mus. Leaflet. Harv. Univ. **8** (1940) 71.—Also in Georgia, Alabama, and Mississippi.
6. *Calopogon pallidus* Chapm. Fl. S.U.S., ed. 1 (1860) 457.—Also north to North Carolina, and west to Mississippi.
7. *Calopogon pulchellus* (Salisb.) R. Br. in Ait. Hort. Kew., ed. 2, **5** (1813) 204.—Also north to Newfoundland, and west to Minnesota and Texas.
8. *Campylocentrum pachyrrhizum* (Rchb.f.) Rolfe in Orch. Rev. **11** (1903) 246.—Also in the West Indies, and in northern South America, to Brazil.
9. *Campylocentrum porrectum* (Rchb.f.) Rolfe in Orch. Rev. **11** (1903) 247.—Also in Cuba, Jamaica, Yucatan, and El Salvador.
10. *Centrogenium setaceum* (Ldl.) Schltr. in Beih. Bot. Centralbl. **37**, ii (1920) 453.—Also in the West Indies, from the Bahamas to Trinidad, and in Colombia.
11. *Cleistes divaricata* (L.) Ames Orch. **7** (1922) 21.—Also north to New Jersey, west to Alabama.
12. *Corallorrhiza Wisteriana* Conr. in Journ. Phil. Acad. Nat. Sci. **6** (1829) 145.—Also north to Pennsylvania, Delaware, and Ohio, and west to Texas.
13. *Cranichis muscosa* Sw. Prodr. Veg. Ind. Occ. (1788) 120.—Also in the West Indies, Mexico, Central America, and northern South America.

\*For nos. 1 and 2 of this series see Lloydia **12**(1): 70–71, 1949 and **13**(2): 163–164, 1950.

14. *Cyrtopodium punctatum* (L.) Ldl. Gen. & Sp. Orch. Pl. (1833) 188.—Also in the West Indies, Mexico, Central America, and northern South America.
15. *Epidendrum anceps* Jacq. Select. Stirp. Am. (1763) 224, t. 138.—Also in the West Indies, Mexico, Central America, and much of South America.
16. *Epidendrum Boothianum* Ldl. in Bot. Reg. **24** (1838) Misc., p. 5.—Also in the Bahamas, Cuba, and British Honduras.
17. *Epidendrum cochleatum* L. var. *triandrum* Ames Contrib. Knowl. Orch. Fl. S. Fla. (1904) 16, t. 8.—Endemic to southern Florida. The species is widely distributed in tropical America.
18. *Epidendrum conopseum* R. Br. in Ait. Hort. Kew. ed. 2, **5** (1813) 219.—Also in Georgia, Louisiana, North Carolina, South Carolina, and with a varietal phase in Mexico.
19. *Epidendrum difforme* Jacq. Enum. Pl. Carib. (1760) 29, and Stirp. Select. Am. (1763) 223, t. 136.—Also in Mexico, the West Indies, Central America, and in South America to Brazil and Peru.
20. *Epidendrum nocturnum* Jacq. Enum. Pl. Carib. (1760) 29, and Select. Stirp. Am. (1763) 225, t. 139.—Also in the West Indies, Mexico, Central America, South America to Brazil, Bolivia, and Peru, and introduced into Sierra Leone.
21. *Epidendrum pygmaeum* Hook. in Bot. Mag. **60** (1833) t. 3233.—Also in the West Indies, Mexico, Central America, and South America to Peru, Bolivia, and Brazil.
22. *Epidendrum rigidum* Jacq. Enum. Pl. Carib. (1760) 29, and Select. Stirp. Am. (1763) 222, t. 134.—Also in the West Indies, Mexico, Central America, and South America to Brazil and Bolivia.
23. *Epidendrum strobiliferum* Rchb. f. in Nederl. Kruidk. Arch. **4** (1858) 333.—Also in the West Indies, Central America, and South America.
24. *Epidendrum tampense* Ldl. in Bot. Reg. **33** (1847) sub t. 35.—Also in the Bahamas and Cuba.
25. *Erythroxes querceticola* (Ldl.) Ames Orch. **5** (1915) 29, in footnote.—Also west to Louisiana and Texas, and in the West Indies from the Bahamas to Martinique.
26. *Eulophia alba* (L.) Fawc. & Rendle Fl. Jamaica **1** (1910) 112, t. 22, fig. 4-8.—Also in the West Indies, Mexico, Central America, in South America to Paraguay and Argentina, and in West Africa, where it probably has been introduced.
27. *Eulophia ecristata* (Fern.) Ames Contrib. Knowl. Orch. S. Fla. (1904) 19.—Also in Cuba.
28. *Galeandra Beyrichii* Rchb. f. in Linnaea **22** (1849) 854.—Also in Cuba, and from Costa Rica south to Brazil and Peru.
29. *Habenaria blephariglottis* (Willd.) Hook. Exot. Fl. **2** (1824) t. 87.—Also north to Newfoundland, and west to Mississippi.
30. *Habenaria* × *Chapmanii* (Small) Ames Orch. **4** (1910) 155 (*H. ciliaris* × *H. cristata*).—Also in Georgia and North Carolina.
31. *Habenaria ciliaris* (L.) R. Br. in Ait. Hort. Kew. ed. 2, **5** (1813) 194.—Also north to Ontario and Vermont, and west to Michigan and Texas.
32. *Habenaria clavellata* (Michx.) Spreng. Syst. Veg. **3** (1826) 689.—Also north to Newfoundland and Minnesota, west to Arkansas and Louisiana.
33. *Habenaria cristata* (Michx.) R. Br. in Ait. Hort. Kew. ed. 2, **5** (1813) 194.—Also north to Massachusetts, west to Louisiana and Arkansas.
34. *Habenaria distans* Griseb. Cat. Plant. Cub. (1866) 270.—Also in Cuba, Jamaica, Hispaniola, and Puerto Rico.
35. *Habenaria flava* (L.) R. Br. ex Spreng. Syst. Veg. **3** (1826) 691.—Also north to Nova Scotia and Ontario, and west to Texas.
36. *Habenaria integra* (Nutt.) Spreng. Syst. Veg. **3** (1826) 689.—Also north to New Jersey, and west to Tennessee and Texas.
37. *Habenaria nivea* (Nutt.) Spreng. Syst. Veg. **3** (1826) 689.—Also north to New Jersey and Delaware, west to Texas and Arkansas, and in Cuba.

38. *Habenaria quinqueseta* (Michx.) Sw. Adnot. Bot. (1829) 46.—Also north to South Carolina, and west to Texas.
39. *Habenaria repens* Nutt. Gen. N. Amer. Pl. **2** (1818) 190.—Also in adjacent Southeastern United States, the West Indies, Central America, and in South America to Brazil.
40. *Habenaria strictissima* Rchb. f. var. *odontopetala* (Rchb. f.) L.O. Wms. in Bot. Mus. Leaf. Harv. Univ. **7** (1939) 184.—Also in the West Indies and Central America.
41. *Hexalectris spicata* (Walt.) Barnh. in Torreyia **4** (1904) 121.—Also north to Virginia, and west to Arizona and northern Mexico.
42. *Ionopsis utricularioides* (Sw.) Ldl. Coll. Bot. (1821) t. 39 A.—Also in the West Indies, Mexico, Central America, and in South America to Brazil, Peru, and the Galapagos Islands.
43. *Isotria verticillata* (Muhl.) Raf. in Med. Repos. N. Y. **5** (1808) 357.—Also north to Maine, and west to Michigan and Texas.
44. *Lepanthopsis melanantha* (Rchb. f.) Ames in Bot. Mus. Leaf. Harv. Univ. **1**, ix (1933) 19.—Also in Cuba and Hispaniola.
45. *Liparis elata* Ldl. in Bot. Reg. **14** (1828) t. 1175.—Also in the West Indies, Mexico, Central America, and northern South America.
46. *Listera australis* Ldl. Gen. & Sp. Orch. Pl. (1840) 456.—Also north to Canada, and west along the Gulf Coast.
47. *Macradenia lutescens* R. Br. in Bot. Reg. **8** (1822) t. 612.—Also in the West Indies, from Cuba to Trinidad, and in northern South America.
48. *Malaxis spicata* Sw. Prodr. Veg. Ind. Occ. (1788) 119.—Also in Georgia and South Carolina, and the West Indies.
49. *Malaxis unifolia* Michx. Fl. Bor.-Amer. **2** (1803) 157.—Also north to Newfoundland and Nova Scotia, west to Manitoba and Wisconsin, and in Cuba, Jamaica, and Mexico.
50. *Maxillaria crassifolia* (Ldl.) Rchb. f. in Bonplandia **2** (1854) 16.—Also in the West Indies, Mexico, Central America, and in South America to Brazil.
51. *Maxillaria sanguinea* Rolfe in Kew Bull. (1895) 8.—Also in Costa Rica and Panama.
52. *Oncidium carthaginense* (Jacq.) Sw. in Kōngl. Svensk. Vetén. Acad. Handl. **21** (1800) 240.—Also in Mexico, Central America, and northern South America.
53. *Oncidium floridanum* Ames Sched. Orch. **7** (1924) 13, fig. 2.—Previously considered to be endemic in southern Florida, but now known from the Archipelago de Camagüey in Cuba.
54. *Oncidium luridum* Ldl. in Bot. Reg. **9** (1823) t. 727.—Also in the West Indies, Mexico, Central America, and South America to Peru.
55. *Oncidium variegatum* Sw. in Kōngl. Svensk. Vetén. Acad. Handl. **21** (1800) 240.—Also in the West Indies, principally Cuba and Jamaica.
56. *Pleurothallis gelida* Ldl. in Bot. Reg. **27** (1841) Misc. p. 91.—Also in the West Indies, Mexico, Central America, and northern South America.
57. *Pogonia ophioglossoides* (L.) Ker-Gawl. in Bot. Reg. **2** (1816) t. 148.—Also north to Newfoundland and Nova Scotia, and west to Minnesota and Texas.
58. *Polyprrhiza Lindenii* (Ldl.) Cgn. in Urb. Symb. Ant. **6** (1910) 680.—Also in Cuba.
59. *Polystachya luteola* Hook. Exot. Fl. **2** (1825) t. 103.—Also in the West Indies, Mexico, Central America, South America, and extensively distributed in the paleotropics.
60. *Ponthieva racemosa* (Walt.) Mohr in Contr. U. S. Nat. Herb. **6** (1901) 460.—Also north to Virginia, south in the West Indies, Mexico, Central America, and in South America to Ecuador.
61. *Prescottia oligantha* (Sw.) Ldl. Gen. & Sp. Orch. Pl. (1840) 454.—Also in the West Indies from the Bahamas south, and in Central America.
62. *Spiranthes cernua* (L.) L. C. Rich. in Mém. Mus. Hist. Nat. Paris **4** (1818) 59.—Also north to Nova Scotia, and west to Minnesota, Texas, and New Mexico.

63. *Spiranthes cernua* (L.) L. C. Rich. var. *odorata* (Nutt.) Corr. in Bot. Mus. Leaflet. Harv. Univ. **8** (1940) 79.—Also north to North Carolina, and west to Tennessee and Louisiana.
64. *Spiranthes cranichoides* (Griseb.) Cgn. in Urb. Symb. Ant. **6** (1909) 338.—Also in Cuba.
65. *Spiranthes elata* (Sw.) L. C. Rich. in Mém. Mus. Hist. Nat. Paris **4** (1818) 59.—Also in the West Indies, Mexico, Central America, and to Argentina in South America.
66. *Spiranthes gracilis* (Bigel.) Beck Bot. North & Middle States ed. 1 (1833) 343.—Also north to Nova Scotia, and west to Manitoba and Texas.
67. *Spiranthes gracilis* (Bigel.) Beck var. *brevilabris* (Ldl.) Corr. in Bot. Mus. Leaflet. Harv. Univ. **8** (1940) 74.—Also in Georgia, Louisiana, and Texas.
68. *Spiranthes gracilis* (Bigel.) Beck var. *floridana* (Wherry) Corr. in Bot. Mus. Leaflet. Harv. Univ. **8** (1940) 76.—Also north to North Carolina, and west to Alabama.
69. *Spiranthes Grayi* Ames in Rhodora **6** (1904) 44.—Also north to Massachusetts and Rhode Island, and west to Texas and Mississippi.
70. *Spiranthes* × *laciniata* (Small) Ames Orch. **1** (1905) 120 (*S. praecox* × *S. vernalis*).—Also north to North Carolina, and west to Louisiana.
71. *Spiranthes longilabris* Ldl. Gen. & Sp. Orch. Pl. (1840) 467.—Also north to North Carolina, and west to Texas.
72. *Spiranthes orchiioides* (Sw.) L. C. Rich. in La Sagra, Fl. Cub. Fanerog. **11** (1850) 252.—Also in the West Indies, Mexico, Central America, and in South America to Argentina.
73. *Spiranthes ovalis* Ldl. Gen. & Sp. Orch. Pl. (1840) 466.—Also north to Georgia, west to Oklahoma and Texas.
74. *Spiranthes polyantha* Rchb. f. in Linnaea **18** (1844) 408.—Also in Mexico.
75. *Spiranthes praecox* (Walt.) S. Wats. in A. Gray, Man. Bot. N. U. S. ed. 6 (1890) 504.—Also north to New Jersey, west to Texas.
76. *Spiranthes tortilis* (Sw.) L. C. Rich. in Mém. Mus. Hist. Nat. Paris **4** (1818) 59, excl. syn. *Neottia quadridentata*.—Also in Louisiana, Bermuda, and the West Indies.
77. *Spiranthes vernalis* Engelm. & Gray in Bost. Journ. Nat. Hist. **5** (1845) 236.—Also north to Massachusetts and Ohio, and west to Texas and Arkansas.
78. *Tipularia discolor* (Pursh) Nutt. Gen. N. Amer. Pl. **2** (1818) 195.—Also north to Massachusetts and Ohio, and west to Texas and Arkansas.
79. *Triphora cubensis* (Rchb. f.) Ames Sched. Orch. **7** (1924) 35.—Also in Cuba, Mexico, and Panama.
80. *Triphora trianthophora* (Sw.) Rydb. in Britt. Man. Fl. N. States & Can. ed. 1 (1901) 298.—Also north to Canada and Wisconsin, west to Missouri, and in Mexico and Guatemala.
81. *Tropidia polystachya* (Sw.) Ames Orch. **2** (1908) 262.—Also in Cuba, Jamaica, and Santa Domingo.
82. *Vanilla barbellata* Rchb. f. in Flora **48** (1865) 274.—Also in the Bahamas and Cuba.
83. *Vanilla Dilloniana* Corr. in Amer. Orch. Soc. Bull. **15** (1946) 331, t.—Also in the Bahamas and Cuba.
84. *Vanilla phaeantha* Rchb. f. in Flora **48** (1865) 274.—Also in the West Indies, from the Bahamas to Trinidad.
85. *Vanilla planifolia* Andr. Bot. Repos. **8** (1808) t. 538.—Also in the West Indies, Mexico, Central America, and to Brazil in South America.
86. *Zeuxine strateumatica* (L.) Schltr. in Engl. Bot. Jahrb. **45** (1911) 394.—Introduced and naturalized in Florida from the paleotropics, where it occurs from Afghanistan and China to New Guinea.

#### 4. The Genus *Campylocentrum* in Florida

The orchid genus *Campylocentrum* date sfrom 1881, when George Benthham established it in *Journal of the Linnaean Society* 18, page 337. It is now a rather large group, including some fifty supposedly tenable species, widely distributed in the neotropics from Mexico and South Florida to the Argentine. It is a member of the Sarcanthinae, and is related to the multitudinous genera of the variable angraecoid group.

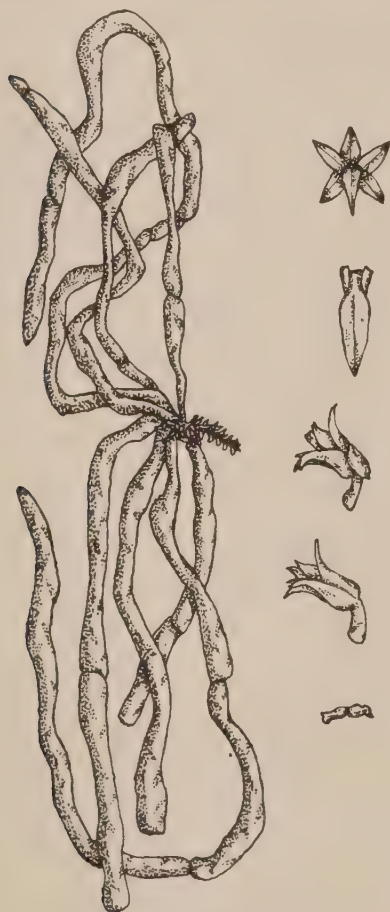


FIG. 1. *Campylocentrum pachyrrhizum* (Rchb.f.) Rolfe. Plant, natural size. 1. Flower, front view. 2. Lip, top view, greatly enlarged. 3. Flower from side, with bract, greatly enlarged. 4. Flower from side, greatly enlarged. 5. Ovary and column, very greatly enlarged.

—Redrawn from F. C. Hoehne by Alex. D. Hawkes, in *Flora Brasilica* 12, i (1940) 8, fig. 8.

Two species of *Campylocentrum* are now known to be indigenous in Florida: *Campylocentrum pachyrrhizum* (Rchb. f.) Rolfe and *C. porrectum* (Rchb. f.) Rolfe. They may be distinguished by the characters utilized in the following key:

- I. Roots round, 1 mm. or less thick, grey or whitish. Flowers few, in simple zigzag racemes, green or yellowish.....2. *C. porrectum* (Rchb. f.) Rolfe
- II. Roots flattened, up to 1 cm. wide, grey, brownish or orange. Flowers numerous, in dense imbricate racemes, green.....1. *C. pachyrrhizum* (Rchb. f.) Rolfe

1. *CAMPYLOCENTRUM PACHYRRHIZUM* (Rchb. f.) Rolfe in Orch. Rev. **11** (1903) 246.

Mature plants leafless; one or two minute, grey-green, leathery bracteoles present in juvenile plants at times. Roots few in number, radiating from central tiny stem, free or attached to tree-host, sinuous, varying in color from grey or brownish to orange or orange-red, up to 60 cm. long, 5 mm. or more broad, occasionally somewhat undulate on flattened edges, generally greatly compressed. Racemes erect, emerging from central obscured stem, densely-flowered, to 3 cm. long, with numerous reddish-brown bracts, 4 mm. long, from which blossoms spring; bracts rather spathaceous, often obscurely dentate marginally, rounded to ovate, acuminate, somewhat cordate. Flowers greenish, delicately membranaceous to rather fleshy, sessile, scarcely opening, to about 5 mm. long, followed by ellipsoidal capsules about 8 mm. long, prominently six-ribbed. Dorsal sepal trinervose, triangular or triangular-lanceolate, sharply acute, 5 mm. long, 1 mm. broad. Lateral sepals more lanceolate than dorsal, uninervose, rather oblique, 5.5 mm. long and 1.3 mm. broad. Petals almost as large as dorsal sepal, trinervose, similar in shape to that segment, but more subulate. Labellum trilobate, with seven more or less prominent nerves, about 4 mm. long and 1.5 mm. broad, with a linear, obscurely clavate spur 2.5 mm. long basally; lateral lobes rather rounded; larger median lobe triangular or lanceolate, acute or acuminate, and sometimes apiculate. Column bright green, short, footless, bearing two globular pollinia in a terminal anther. SOUTH FLORIDA: Fahakahatchee Swamp, Big Cypress, and a few adjacent swampy areas, growing mostly on *Taxodium* and *Anona*, over standing water, in dense shade. Also in the West Indies, and south to Trinidad, French Guiana, and Brazil.

Synonyms: *Aëranthus pachyrrhizus* Rchb. f. in Flora **48** (1865) 279.  
*Aëranthus spathaceus* Griseb. Cat. Pl. Cub. (1866) 264.

2. *CAMPYLOCENTRUM PORRECTUM* (Rchb. f.) Rolfe in Orch. Rev. **11** (1903) 247.

Leafless when mature; bearing abortive bracteoles when juvenile. Stem at center about 1 mm. long, from which roots radiate, and whence inflorescences appear. Roots mostly free, arcuate, rigid, flexuose, simple, greyish-white, up to 1 dm. long and 0.5 mm. wide. Rachis of the inflorescence filiform, elongate, rarely branched, zigzag, with several large obtuse, semi-tubular bracts scattered throughout its length and one at the base of each flower. Blossoms proportionately large, about 2 mm. long, yellowish-green or yellowish, ephemeral. Pedicellate

EXPLANATION OF FIG. 2.

FIG. 2. *Campylocentrum porrectum* (Rchb. f.) Rolfe.—1. Fruiting plant, in natural habitat, natural size. 2. Flowering plant, natural size. 3. Flower, side view, much enlarged. 4. Flower, ventral view, much enlarged. 5. Flower, front view, much enlarged. 6. Lip and spur, from above, much enlarged. 7. Lateral sepal, much enlarged. 8. Dorsal sepal, much enlarged. 9. Petal, much enlarged. 10. Column and ovary, much enlarged. 11. Pollen masses, highly magnified. 12. Flower bud, much enlarged. 13. Fruiting ovaries, much enlarged.



FIG. 2. *Campylocentrum porrectum* (Rchb. f. Rolfe.

Redrawn from Blanche Ames by Gordon W. Dillon, in *Drawings of Florida Orchids*, t. 62.

ovary constricted basally, about 2.5 mm. long, rather densely glandular along six lines which extend vertically along its entire length. Sepals about 2 mm. long, the dorsal 0.8 mm. broad, oval-elliptical, obtuse, membranaceous, prominently nervose; laterals 1 mm. across, membranaceous, nervose, oval, oblique, acute. Petals about the same length as the sepals, 0.7 mm. broad, linear, obtuse, apiculate, uninnervose. Lip about 2.5 mm. long, with a globular spur 0.7 mm. long attached at base; labellum slightly and obtusely apiculate, inconspicuously trilobate, somewhat deeply and irregularly excavated. Column terete, rather contracted. Capsules generally present after each flower, persistent, 6 mm. long, 5 mm. broad, dehisce from apex to form a several-segmented organ. SOUTH FLORIDA: Rather extensively distributed in South Florida, and reported as far north as Kissimmee, usually on naturalized Rutaceous trees or *Taxodium*; in swamps or hammock formations, usually in the shade. Apparently delights in growing on small twigs or branchlets, which are often dead and partly decayed. Also in Cuba, Jamaica, Yucatan, and El Salvador.

Synonyms: *Aëranthus porrectus* Rchb. f. in Flora **48** (1865) 279.

*Harrisella porrecta* Fawc. & Rendle in Journ. of Bot. **47** (1909) 266.

*Harrisella Amesiana* Cgn. in Urban Symb. Antill. **6** (1910) 687.

The writer wishes to express his sincere gratitude to the late Professor Oakes Ames and Dr. F. C. Hoehne for kind permission to utilize the accompanying plates of *Campylocentrum*.

## 5. The Genus *Spiranthes* in Florida

The large orchid genus *Spiranthes* L. C. Rich. is cosmopolitan in its distribution. In the state of Florida sixteen species and varieties are now considered indigenous, some widespread and in great quantities, others rare and highly localized in their distribution. Though often among the most common of our terrestrial species, these interesting dwarf orchids are today perhaps the least understood of all orchids occurring within our area. Considerable taxonomic study and revision still remains to be done on the genus as a whole, as well as on our native plants, before we may safely state that its limitations and identities are fully understood. Therefore the following is not to be construed as a monographic treatment of *Spiranthes* in Florida, but rather as a contribution toward our knowledge of these orchids in this flora.

### KEY TO THE FLORIDA SPIRANTHES SPECIES

- I. Flowers in a single rank.
  - A. Leaves rarely persistent, ovate or elliptic.
    1. Flowers very numerous, up to 100 per spike...13. *S. polyantha* Rchb. f.
    1. Flowers many less than 100 per spike.
      - a. Lip entirely white.....8. *S. Grayi* Ames
      - a. Lip with a green or yellow center.
        2. Lip with a yellow center.....7. *S. gracilis* var. *floridana* (Wherry) Corr.
        2. Lip with a green center.
          - b. Stem glabrous.....5. *S. gracilis* (Bigel.) Beck
          - b. Stem densely pubescent.....6. *S. gracilis* var. *brevilabris* (Ldl.) Corr.
  - A. Leaves persistent, or withering, oblong-lanceolate to linear-lanceolate.
    1. Basal leaves mostly absent at flowering time.
      - a. Flowers secund, spiral.....15. *S. tortilis* (Sw.) L. C. Rich.
      - a. Flowers secund, not spiral.....10. *S. longilabris* Ldl.
    1. Leaves mostly persistent.
      - a. Lip pubescent beneath.
        2. Lip lacinate at the tip.....9. *S. laciniata* (Small) Ames
        2. Lip not lacinate at the tip.....16. *S. vernalis* Engelm. & Gray
      - a. Lip glabrous beneath.
        2. Lip elongate-pandurate, constricted near middle.....4. *S. elata* (Sw.) L. C. Rich.
        2. Lip oblong, not constricted near middle.....14. *S. praecox* (Walt.) S. Wats.
- I. Flowers in several ranks, not secund.
  - A. Flowers red or green, large.....11. *S. orchiodes* (Sw.) L. C. Rich.
  - A. Flowers white or yellowish, small.
    1. Leaves grass-like, linear or linear-lanceolate.
      - a. Flowers about 5 mm. long, usually odorless.....12. *S. ovalis* Ldl.
      - a. Flowers about 10 mm. long, usually highly fragrant of vanilla.
        2. Lip pure white; habit slender.....1. *S. cernua* (L.) L. C. Rich.
        2. Lip marked with green or cream; habit robust.....2. *S. cernua* var. *odorata* (Nutt.) Corr.
    1. Leaves ovate-elliptic, petioled.....3. *S. cranichoides* (Griseb.) Cgn.

1. *SPIRANTHES CERNUA* (L.) L. C. Rich. in Mém. Mus. Hist. Nat. Par. 4 (1818) 59.

*Orchis cernua* L. Sp. Plant. ed. 1, 2 (1753) 946.

*Gyrostachys cernua* O. Ktze. Rev. Gen. Plant. 2 (1891) 664.

*Ibidium cernuum* House in Bull. Torr. Bot. Club 32 (1905) 381.

? *Ibidium incurvum* Jennings in Ann. Carnegie Mus. 3 (1906) 483, t. 20.

*Triorchis cernua* Nieuwl. in Amer. Midl. Nat. 3 (1913) 122.

Stems springing from thick, hirsute roots, to 60 cm. high, with a few basal leaves and several somewhat foliose bracts on upper reaches. Leaves to 35 cm. long, linear-lanceolate to oblong, sessile or contracted into petioles up to 5 cm. long, acutish. Flowers several to many, fragrant, white, 10 mm. long, often somewhat nutant, in a spike to 17 cm. long. Dorsal sepal connate with petals over other segments, ovate-lanceolate, somewhat acuminate, with inrolled lower margins. Lateral sepals free, lanceolate, acuminate, rather spreading toward tip, densely pubescent on outer surface. Petals curved, connivent with dorsal sepal, narrowly ovate-lanceolate, obtuse or truncate at the apex, about as long as the sepals, and rather strongly falcate. Lip simple, varying in shape from ovate to oblong, about 10 mm. long, very crisped on margins, sharply deflexed at extreme apex, with two blunt conical calli at base, one on each side of short broad claw. Capsules more or less erect, about 9 mm. long.

Peninsular Florida, common in northern and central portions, but rarer southward. Also from Nova Scotia west to Minnesota, south to Texas and New Mexico. Flowers mostly in summer.

2. *SPIRANTHES CERNUA* (L.) L. C. Rich. var. *ODORATA* (Nutt.) Corr. in Bot. Mus. Leaflet Harv. Univ. 8 (1940) 79.

*Neottia odorata* Nutt. in Journ. Acad. Nat. Sci. Phila. 7 (1834) 98.

*Spiranthes odorata* Ldl. Gen. & Sp. Orch. Pl. (1840) 467.

*Gyrostachys odorata* O. Ktze. Rev. Gen. Pl. 2 (1891) 664.

*Ibidium odoratum* House in Muhlenbergia 1 (1906) 128.

"Similar in habit to the species, stoloniferous. Roots long, fleshy, coarse. Plant erect, stout or slender, often very succulent, glabrous below, downy-pubescent above, 1.8–9.5 dm. tall. Leaves mostly basal, often extending up the stem, linear to lanceolate, 5–40 cm. long, 5–20 mm. wide. Inflorescence a densely flowered compact spike of tubular ringent flowers in several spiral or vertical ranks, 4.5–18 cm. long, 1–3 cm. in diameter. Floral bracts lanceolate, acuminate-attenuate, mostly longer than the flowers, 8–15 mm. long. Flowers white, marked with green or cream-tinged, very fragrant of vanilla. Sepals oblong-lanceolate to lanceolate, acute to acuminate, 6–13.5 mm. long; lateral sepals free. Petals coherent with the dorsal sepal, linear, obtuse to acute, 6–13.5 mm. long, 1–2 mm. wide. Lip with the basal half dilated, rhomboidal, tapering to the obtuse apex, broadly ovate to broadly triangular, 6–14 mm. long, 3.5–8 mm. wide near the base; basal callosities prominent, recurved. Column about 5 mm. long."\*

\*D. S. Correll, in l. c.

Peninsular Florida, rarer toward the south, but rather common in the central area. Also from North Carolina west to Tennessee and south to Louisiana. Flowers mostly in the winter, but sometimes in spring and early summer months.

3. *SPIRANTHES CRANICHOIDES* (Griseb.) Cgn. in Urb. Symb. Antill. 6 (1909) 338.

*Pelexia cranichoides* Griseb. Cat. Plant. Cub. (1866) 269.

*Spiranthes Storeri* Chapm. Fl. S. U. S., ed. 3 (1897) 488.

*Beadlea Storeri* Small Fl. S. E. U. S., ed. 1 (1903) 319.

*Sauroglossum cranichoides* Ames in Proc. Biol. Soc. Wash. 17 (1904) 117.

*Beadlea cranichoides* Small Fl. S. E. U. S., ed. 2 (1913) 320.

*Cyclopogon cranichoides* Schltr. in Beih. Bot. Centralbl. 37, Abt. 2 (1920) 387.

Frequently gregarious. Roots several, tuber-like, 4 cm. long, about 12 mm. in diameter. Leaves five or six, ovate, with 5 cm. long petioles, borne at base of erect stem, about 6 cm. long, acute or acuminate at the apex, rather rounded toward base of blade; usually dark green on upper surface, sometimes suffused with purple below. Scape bracts rather large, often turned out at apex, sometimes white-spotted. Stem erect, to 40 cm. high, pubescent above, bearing a spike up to 10 cm. long with 12 or less flowers. Flowers green and white, suffused with wine-purple, about 7 mm. long in larger phases. Pedicellate-ovaries about 6.5 mm. long, pubescent. Dorsal sepal somewhat connate with petals, rather ovate or ovate-lanceolate, obtuse, up to 5.5 mm. long. Lateral sepals pubescent basally, as is the dorsal, green, suffused with wine-purple, oblique, lanceolate, acutish, somewhat shorter than dorsal. Petals white, tinged basally with greenish, about 4 mm. long, spatulate or linear-spatulate, acutish or apiculate, somewhat connate with dorsal sepal. Lip trilobate, to 7 mm. long, white, with a fleshy callus on each side of the base, which is adnate to the column; median lobe more or less trapezoid-shaped, acute or apiculate, usually pendent; lateral lobes rounded, obscurely dentate on forward margins, truncate or obtuse apically. Column slender, clavate, about 4 mm. long, with an erect ovate anther on its back surface. Capsules usually erect, generally produced in abundance.

Sparsely distributed in a few hammocks in south-central and southern Florida. Also in Cuba. Flowers mostly in the spring.

4. *SPIRANTHES ELATA* (Sw.) L. C. Rich. in Mém. Mus. Hist. Nat. Par. 4 (1818) 59.

*Satyrium elatum* Sw. Prodr. Veg. Ind. Occ. (1788) 119.

*Neottia elata* Sw. in Act. Holm. (1800) 266.

*Pelexia spiranthoides* Griseb. Cat. Pl. Cub. (1866) 269, nec Ldl., nec Griseb. Fl.

*Spiranthes elata* var. *ovata* Cgn. in Mart. Fl. Bras. 3, iv (1895) 192.

*Sauroglossum Richardii* Ames Orch. 1 (1905) 44, in textu.

*Beadlea elata* Small ex Britt. in Mem. Brooklyn Bot. Gard. 1 (1918) 38.

*Cyclopogon elatus* Schltr. in Fedde Rep. Beih. 6 (1919) 53.

*Spiranthes Pamii* Braid in Kew Bull. (1924) 204.

*Spiranthes Pamii* var. *brevipetiolatus* Braid, l. c.

*Spiranthes Pamii* var. *bruneolus* Braid, l. c.

*Spiranthes Pamii* var. *spiralis* Braid, l. c.

Roots thick, hairy, several in number. Leaves in a rosette, two to six, glabrous, petiolate, to 14 cm. long and 5.5 cm. wide, rather variable

in shape, generally more or less elliptical or lanceolate-ovate; petioles marked, somewhat clasping basally, to 7 cm. long. Erect scape tomentose in raceme portion, to 40 cm. high, with a few nodding greenish or brownish flowers. Flowers 6–10 mm. long, shortly pedicellate, with maculate basal bracts to 12 mm. long and 2 mm. broad. Scape-bracts several, sheathing, about 10 cm. long, the free portions of which are oblong-lanceolate and acute. Dorsal sepal rather roughened in texture, uninervose, more or less oblong or linear-lanceolate, acute or obtuse, to 7 mm. long and 1.5 mm. broad, greenish or brownish-green. Laterals similar in color and texture, somewhat falcate, obliquely enlarged basally, linear-lanceolate or linear-oblong, more or less obtuse, up to 7 mm. long and 1.3 mm. broad, slightly broader basally. Petals similar in color, sometimes suffused with pink or reddish at tip, linear-spatulate or oblanceolate, obtuse, uninervose, to 5.5 mm. long and about 0.5 mm. broad. Lip somewhat pandurate basally, about 3.5 mm. across there, sharply constricted into an isthmus near middle which is about 1 mm. broad, thence expanding to form a rather round terminal area which is slightly crenulate and somewhat wider than base; slight sac-like depression at base with two tiny calli; lip about 6.5 mm. long, whitish suffused with pink or brown near tip, with a few green streaks in center. Column pubescent on front of apex, to 3.5 mm. long. Capsule ovoid-oblong, to about 9 mm. long, 4 mm. in diameter.

Very rarely found in South Florida, in hammocks. Also in Mexico and the West Indies to Argentina in South America. Flowers in the spring months.

5. *SPIRANTHES GRACILIS* (Bigel.) Beck Bot. North. & Middle States, ed. 1 (1833) 343.

*Neottia gracilis* Bigel. Florula Boston., ed. 2 (1824) 322.

*Gyrostachys gracilis* O. Ktze. Rev. Gen. Plant. **2** (1891) 664.

*Ibidium gracile* House in Bull. Torr. Bot. Club **32** (1905) 381.

*Triorchis gracilis* Nieuwl. in Amer. Midl. Nat. **3** (1913) 123.

Roots clustered, thick, hairy. Leaves short-lived, borne in a rosette, often withered before appearance of flowers, three or four, slightly petiolate, ovate to elliptic-lanceolate, acute or obtuse, about 6 cm. long. Stem very slender, erect, 30 cm. or less high, bearing a single-ranked twisted spike on the apical 12 cm. or less, set with several sheathing, lanceolate, acutish bracts. Flowers about 5 mm. long, glistening white with a wide emerald-green stripe down middle of labellum, often deliciously fragrant. Dorsal sepal connate with the petals, rather upturned at apex, oblanceolate, acutish, obscurely denticulate toward apex. Lateral sepals slightly spreading, lanceolate, acute, rather folded down middle. Petals connivent with dorsal sepal, obovate to oblanceolate, acutish, somewhat crenulate toward tip. Lip oblong, slightly shorter than sepals, hyaline, white, with broad brilliant green strip down center of disc, crenulate and revolute apically, with short broad claw at base and a hirsute conical callus on each side.

Peninsular Florida, considerably rarer in southern part than elsewhere. Also from Nova Scotia west to Manitoba and south to Texas. Flowers in spring and early summer.

6. *SPIRANTHES GRACILIS* (Bigel.) Beck var. *BREVLABRIS* (Ldl.) Corr. in Bot. Mus. Leaf. Harv. Univ. **8** (1940) 74.

*Spiranthes brevilabris* Ldl. Gen. & Sp. Orch. Pl. (1840) 471.

"Similar to the species except for the densely pubescent spike. Rachis with whitish pubescence; ovaries more or less covered with a dense mat of reddish brown hairs (rarely sparsely pubescent); perianth parts somewhat pubescent on the outer surface. Plant 1-3.5 dm. tall. Leaves similar to those of the species, mostly persistent. Spike 2-15 cm. long. Floral bracts usually much longer than in the species, 5-14 mm. long, awn-like at the apex. Flowers apparently white or cream-colored (no fresh material was seen). Petals usually irregularly eroded near the apex. Lip with longer and more finely lacerate fringes than in the species (often fringed along the margin to the base), strongly arcuate-decurved, often conspicuously constricted at the middle, with a dense tuft of hairs on the disc near the apex; basal callosities thick, stout, prominent."\*

Southern Peninsular Florida, mostly on the western side, where it is a rare plant. Also in Georgia, Louisiana, and Texas. Flowers principally in the early spring.

7. *SPIRANTHES GRACILIS* (Bigel.) Beck var. *FLORIDANA* (Wherry) Corr. in Bot. Mus. Leaf. Harv. Univ. **8** (1940) 76.

*Ibidium floridanum* Wherry in Journ. Wash. Acad. Sci. **21** (1931) 49.

*Spiranthes floridana* Cory in *Rhodora* **38** (1936) 405.

"Similar to the species except for the lip having a yellow (instead of green) center and having persistent leaves which are narrower and elongate. The variety also differs markedly from the species in that the spike is secund (rarely spiral). Plant glabrous (occasionally sparsely pubescent above), 1.4-5.5 dm. tall; stem and leaves light green or yellowish green. Lateral sepals narrowly lanceolate, acuminate, projecting horizontally and conspicuously beyond the arcuate-decurved lip. Petals often irregularly eroded near the apex. Lip ovate to ovate-oblong, truncate or rarely retuse; median portion of the disc yellow (rarely with an obsolete tuft of hairs on the disc near the apex); basal callosities stout or slender."\*

Peninsular Florida, where it is often rather common and gregarious. Also from North Carolina west to Alabama. Flowers in winter and spring.

8. *SPIRANTHES GRAYI* Ames in *Rhodora* **6** (1904) 44.

*Spiranthes Beckii* Ldl. Gen. & Sp. Orch. Pl. (1840) 472, excl. syn.

*Spiranthes simplex* A. Gray Man. Bot. N. U. S., ed. 5 (1867) 506, non Griseb.

*Gyrostachys simplex* O. Ktze. Rev. Gen. Plant. **2** (1891) 664.

*Gyrostachys Grayi* Britt. Man. Fl. N. States & Can., ed 2. (1905) 300.

*Ibidium Beckii* House in *Muhlenbergia* **1** (1906) 128.

*Gyrostachys Beckii* W. Stone Pl. S. N. J. (1912) 375.

*Triorchis Grayi* Nieuwl. in Amer. Midl. Nat. **3** (1913) 123, in nota.

*Triorchis Beckii* House, l. c., **6** (1920) 206.

Root single, tuberous, usually tightly buried in hard soil. Leaves basal, oblong, petiolate, early deciduous, generally less than 4 cm.

\*D. S. Correll, in l. c.

long and 8 mm. broad. Inflorescence erect, slender, wiry, to 30 cm. high, bearing a glabrous spike of small white flowers and several small, acute bracts which soon wither upon reaching maturity. Flowers only about 5 mm. long, glistening pure white, rather fugacious, tubular, borne in a twisted one-sided raceme about 3-6 cm. long. Dorsal sepal ovate or somewhat elliptic-ovate, connivent to form small galea with petals, rather obtuse. Lateral sepals ovate-lanceolate, more acutish than dorsal, introrse on lower edges. Petals linear to linear-spatulate, somewhat falcate, truncate or obtuse, slightly apiculate. Lip about 3 mm. long and wide, oblong, crisped and undulate almost all around margin, with a pair of small blunt calli near base, which is slightly clawed. Column short, with two granular pollinia, one in each sac of anther, which is situated on the back of the gynostemium apex. Capsules erect, about 5 mm. long when mature.

Peninsular Florida, rarer in the southern portion, usually in dry places. Also from Massachusetts and Rhode Island west to Texas, south to Mississippi. Flowers in the summer months.

9.  $\times$  *SPIRANTHES LACINIATA* (Small) Ames Orch. 1 (1905) 120. (*S. praecox*  $\times$  *S. vernalis*).

*Gyrostachys laciniata* Small Fl. S. E. U. S., ed. 1 (1903) 318.

*Ibidium laciniatum* House in Muhlenbergia 1 (1906) 128.

*Triorchis laciniata* House in Amer. Midl. Nat. 6 (1920) 206.

Natural hybrid between *S. praecox* and *S. vernalis*. Plants to a meter or more high. Roots clustered, long, fleshy, numerous. Leaves several, thick, folded, borne near base and a short distance up stem, linear-lanceolate to rather oblanceolate, acuminate, to 35 cm. or more long, 2 cm. wide, gradually merging into stem-bracts. Stem erect, highly variable in height and thickness, glabrous basally, very pubescent toward floral-bearing portion, distinguished easily from *Spiranthes vernalis* by capitate pubescence. Bracts sheathing, rather acuminate, elongated, merging with foliage, generally longer than pedicellate-ovaries in raceme, ovate-lanceolate, acuminate. Flowers whitish, fragrant, to 11 mm. long, tubular, rather pubescent on outside, produced in second or slightly spiral spike to 25 cm. long, thirty or more in number. Sepals trinervose, linear-oblong, obtuse, usually with a more or less ciliate margin, slightly narrower apically, generally about 10 or 11 mm. long and 2.5 mm. wide basally. Petals sometimes touch dorsal sepal, which forms a galea over column and lip, 9 mm. long, trinervose, somewhat falcate, obtuse. Lip more or less oblong, 8.5 mm. long, considerably shorter than sepals, narrowing apically, where it is laciniate and denticulate, usually conspicuously pubescent beneath, at broad base bearing a pair of rather long, arcuate, calli-like projections.

Peninsular Florida, usually in wet or boggy places, often very common. Also in coastal Southeastern States from North Carolina to Louisiana. Flowers in the summer.

10. *SPIRANTHES LONGILABRIS* Ldl. Gen. & Sp. Orch. Pl. (1840) 467.

*Spiranthes brevifolia* Chapm. Fl. S. U. S., ed. 1 (1860) 462.

*Gyrostachys brevifolia* O. Ktze. Rev. Gen. Plant. 2 (1891) 664.

*Gyrostachys longilabris* O. Ktze., l. c.

*Ibidium longilabris* House in Muhlenbergia 1 (1906) 128.

*Triorchis longilabris* House in Amer. Midl. Nat. 6 (1920) 206.

Plant sometimes 6 dm. high, often curved rather than stiffly erect. Roots numerous, bunched, fleshy. Leaves soon deciduous, few, linear, acute, about 10 cm. long and 6 mm. wide, merging with leafy bracts on stem to base of floral-bearing portion. Stem to 60 cm. high, often pubescent above, bearing a second or second-spiral spike to 10 cm. long, with twenty or more flowers on upper portion. Flowers large, 8 mm. long, white, with a yellowish lip, fugacious. Sepals pubescent outside, linear-oblong and rather obtuse in shape, about 8 mm. long and 2 mm. broad at widest point, dorsal frequently a little longer than laterals, thrust forward over column and lip in a galea in conjunction with petals. Petals linear to linear-oblong, more or less acutish and often dentate apically, wider toward tip, about as long as lateral sepals, though not as wide. Lip shaded with yellowish, about 10 mm. long, dentate apically, narrowly oblong to ovate-oblong, obtuse, with a pair of glabrous conical calli at base, one on either side of junction with column.

Peninsular Florida, usually in pinelands or moist meadows or glades, often in great profusion. Also in Southeastern States from North Carolina to Texas, along Gulf Coast. Flowers usually in winter months, from October to February.

11. *SPIRANTHES ORCHIOIDES* (Sw.) L. C. Rich. in La Sagra, Fl. Cub. Fanerog. **11** (1850) 252.

*Satyrium orchioides* Sw. Prodr. Veg. Ind. Occ. (1788) 118.

*Neottia squamulosa* HBK Nov. Gen. & Sp. **1** (1816) 332, t. 71.

*Stenorrhynchus orchioides* L. C. Rich. in Mém. Mus. Hist. Nat. Par. **4** (1818) 59.

*Stenorrhynchus squamulosus* Sprgl. Syst. Veg. **3** (1826) 710.

*Spiranthes jaliscana* S. Wats. in Proc. Amer. Acad. **26** (1891) 153.

*Gyrostachys orchioides* O. Ktze. Rev. Gen. Plant. **2** (1891) 664.

*Stenorrhynchus jaliscanus* Nash in Bull. Torr. Bot. Club **22** (1895) 158.

Roots clustered, thick, clavate, brownish-grey, very large. Leaves deciduous, produced after flowers fade, several, glabrous, dark glossy green, up to 20 cm. long and 4 cm. broad, often prostrate on ground, elliptic-lanceolate to oblong, generally acutish, narrowing slightly at base, rather membranaceous in texture. Inflorescences to 60 cm. high (in Florida material, considerably higher elsewhere), set with several sheathing, lanceolate, acute bracts to 3 cm. long which become larger and more ovate toward base of stem. Flowers twenty or less, 3 cm. long, highly variable in color—from pure white to green through a multitude of red shades, often brick-red in Florida—tubular, densely pubescent on outer surface, quickly fading. Sepals densely pubescent on outside, more or less spreading at tips; dorsal connate with petals to form a hood over the column and labellum, 2 cm. long, lanceolate to triangular-lanceolate in shape, generally acute. Lateral sepals more spreading than dorsal, longer, lanceolate, acute, forming an obtuse spur-like mentum basally. Petals connate with dorsal sepal, considerably shorter, about 15 mm. long, generally elliptic and obtuse, often rather hyaline, especially along the margins. Lip entire, lanceolate, ciliate basally, about 2.5 cm. long, 9 mm. broad, acute to somewhat acuminate. Column erect, to 7 mm. long, with an anther bearing two powdery pollinia on dorsal tip. Capsules globose-ovoid, about 2 cm. long, with dried perianth-remains attached to apex.

North-central and central peninsular Florida, considerably rarer southward, and probably not occurring in extreme southern portions of the state. Also in the West Indies, Mexico, Central America, and to Argentina. Flowers mostly in May and June in Florida.

12. *SPIRANTHES OVALIS* Ldl. Gen. & Sp. Orch. Pl. (1840) 466.

*Gyrostachys ovalis* O. Ktze. Rev. Gen. Plant. **2** (1891) 664.

*Spiranthes cernua* var. *parviflora* Chapm. Fl. S. U. S., ed. 3 (1897) 488.

*Gyrostachys parviflora* Small Fl. S. E. U. S., ed. 1 (1903) 318.

*Spiranthes parviflora* Ames Orch. **1** (1905) 137.

*Ibidium ovalis* House in Muhlenbergia **1** (1906) 128.

*Ibidium parviflorum* Jennings in Ann. Carneg. Mus. **3** (1906) 485.

*Triorchis ovalis* Nieuwl. in Amer. Midl. Nat. **3** (1913) 123, in footnote.

*Spiranthes Smallii* Schltr. in Beih. Bot. Centralbl. **37**, Abt. **2** (1920) 358.

Roots few, fleshy, clustered. Leaves several, linear-lanceolate, grassy, acute or somewhat obtuse, to 12 cm. long, expanded and sheathing basally, extending half-way up stem, gradually merging with sheathing bracts toward spike. Stem erect, to 65 cm. high, with a short, several-ranked spike of roughly oval outline on upper 8 cm. or so. Flowers pure white, furnished with lanceolate acuminate bracts slightly shorter than themselves. Dorsal sepal connate with linear-lanceolate petals, similar to them in shape, but somewhat larger and longer, upturned at tip. Lateral sepals lanceolate, somewhat expanded basally, undulate on lower edges, acuminate, only slightly spreading. Lip about 5 mm. long, oblong to rhomboidal, rather acute, somewhat crenulate toward apex, with a blunt callus on each side of shortly clawed base.

Rarely encountered in the northern part of peninsular Florida. Also from Georgia west to Oklahoma and Texas. Flowers in late summer.

13. *SPIRANTHES POLYANTHA* Richb. f. in Linnaea **18** (1844) 408.

A rare species, found only once here, probably extinct within our area. Leaves basal, persistent at flowering time, ovate to oblong in shape, acute. Scape-bracts rather loose, with stiff cuspidate acuminate apices. Floral bracts lanceolate, similarly cuspidate, not as long as pedicellate ovaries. Stem slender, to 4.5 dm. tall, very abundantly flowered, with often as many as a hundred blossoms. Flowers white, deflexed. Sepals lanceolate, acute. Petals similar in shape, but slightly smaller. Lip lanceolate, with a pair of small sharp calli at dilated base, 5-nerved, cuspidate at apex.

An incompletely-known species, found only once in southern Florida, probably extinct within our area now. Also in Mexico. Flowering time unknown.

14. *SPIRANTHES PRAECOX* (Walt.) S. Wats. in A. Gray, Man. Bot. N. U. S., ed. 6 (1890) 504.

*Limodorum praecox* Walt. Fl. Carol. (1788) 221.

*Spiranthes tortilis* Chapm. Fl. S. U. S., ed. 1 (1860) 462, non L. C. Rich.

*Spiranthes graminea* var. *Walteri* A. Gray Man. Bot. N. U. S., ed. 5 (1867) 505, as to syn.

*Gyrostachys praecox* O. Ktze. Rev. Gen. Plant. **2** (1891) 663, excl. syn. *S. Beckii* Ldl.

*Ibidium praecox* House of Muhlenbergia **1** (1906) 129.

*Triorchis praecox* Nieuwl. in Amer. Midl. Nat. **3** (1913) 123, in footnote.

Leaves 35 cm. long or less, only a few millimeters wide, grassy, narrowly sheathing at base, linear; usually there is a single leaf at or near base of stem which is considerably longer than others. Stem erect, to 8 dm. high, bearing leaves to within a short distance of floral-producing portion, with a spirally twisted spike to 12 cm. long at apex. Floral bracts often somewhat imbricate, about as long as pedicellate-ovaries. Flowers white or pale yellow, slightly nutant, pleasantly fragrant, rather pubescent on outside, about 8 mm. long. Dorsal sepal lanceolate, somewhat connivent with petals, acutish. Lateral sepals lanceolate, acutish, free, rather spreading, about 5 mm. long, often with incurved edges, sometimes curved down slightly below labellum rather than at its sides. Petals connate with dorsal sepal, slightly smaller than dorsal, with upcurved apices. Lip oblong to obovate, about 6 mm. long, somewhat downcurved and retrorse apically, crenulate marginally, particularly near tip, sometimes with darker stripes down middle of disc, with a pair of recurved blunt calli at base of slender claw, one on each side. Capsule about 8 mm. long, rather clavate and nutant.

Peninsular Florida, rarer in southern portion. Also from New Jersey south to the Gulf of Mexico, west to Texas. Flowers mostly in the spring.

15. *SPIRANTHES TORTILIS* (Sw.) L. C. Rich. in Mém. Mus. Hist. Nat. Par. 4 (1818) 59, excl. syn. *Neottia quadridentata*.

*Satyrium spirale* Sw. Prodr. Veg. Ind. Occ. (1788) 118, non *Ophrys spiralis* L.

*Neottia tortilis* Sw. in Kong. Svensk. Vet. Acad. Nya Handl. 21 (1800) 226.

*Ibidium tortile* House in Muhlenbergia 1 (1906) 129.

*Triorchis spiralis* House in Amer. Midl. Nat. 6 (1920) 206.

*Spiranthes Amesiana* Schltr. in Beih. Bot. Centralbl. 37, Abt. 2 (1920) 348.

*Gyrostachys peruviana* O. Ktze. Rev. Gen. Plant. 2 (1891) 663, non *Ophrys peruviana* Aubl.

Roots thick, clustered or solitary. Leaves few, linear to linear-lanceolate, usually deteriorating before anthesis, erect, clasping base of stem, basal, to 20 cm. long, 4 mm. broad, acute, enlarged slightly at base. Stem to 45 cm. high, slender, erect, bearing six to eight sheathing bracts which are 3 cm. long and lanceolate in their free apical portion. Spike to 13 cm. long, with numerous curved flowers in a dense spiral raceme which is typically secund. Flowers often nutant, white, with bright green disc on labellum, about 9 mm. long, with a pubescent pedicellate-ovary which is usually shorter than subtending floral bract, which is in turn puberulous, ovate, acuminate, and about 7 mm. long. Sepals trinervose, minutely puberulous, the laterals 5 mm. long and 2 mm. broad, lanceolate or oblong, obtuse or acutish, oblique basally; dorsal about 1 mm. longer, similar in width, elliptical to oblong, obtuse. Petals trinervose, oblong, about 6 mm. long, rounded at apex, somewhat narrowing basally. Lip about 5.5 mm. long and almost 4 mm. broad, ovate-elliptic or ovate, emarginate basally, crenulate, curled on upper portion, cordate basally, with numerous nerves, and a particularly prominent median nerve toward tip, with two cone-like calli at base, bright green shading to whitish at margins. Column usually about 2 mm. long, green; rostellum bidentate, connected with clinandrium

by wide wings, with a brown anther containing two granular pollinia. Capsule to 9 mm. long, 4 mm. in diameter, obovoid-oblong.

Southern peninsular Florida and the Keys, usually in pinelands among rocks. Also in Louisiana, Bermuda, and the West Indies. Flowers in May and June.

16. *SPIRANTHES VERNALIS* Engelm. & Gray in Bost. Journ. Nat. Hist. **5** (1845) 236.

*Spiranthes graminea* var. *Walleri* A. Gray Man. Bot. N. U. S., ed. 5 (1867) 505, as to plant described.

*Spiranthes graminea* var. *praecox* Britt., Sterns & Poggbg. Prel. Cat. Anth. & Pter. N. Y. (1888) 52.

*Gyrostachys vernalis* O. Ktze. Rev. Gen. Plant. **2** (1891) 664.

*Gyrostachys praecox* Britt. & Brown Ill. Fl. N. U. S., Can., ed. 1, **1** (1896) 471, in part.

*Gyrostachys Reverchonii* Small in Bull. Torr. Bot. Club **25** (1898) 610.

*Gyrostachys linearis* Rydbg. in Britt., Man. Fl. N. States & Can., ed. 1 (1901) 300.

*Gyrostachys xyridifolia* Small Fl. S. E. U. S., ed. 1 (1903) 318.

× *Spiranthes intermedia* Ames in Rhodora **5** (1903), 262, t. 47.

*Spiranthes neglecta* Ames, l. c., **6** (1904) 30, t. 51, f. 1.

*Ibidium vernalis* House in Bull. Torr. Bot. Club **32** (1905) 381.

× *Ibidium intermedium* House in Muhlenbergia **1** (1906) 129.

*Ibidium xyridifolium* Small Fl. S. E. U. S., ed. 2 (1913) 319.

*Triorchis linearis* Nieuwl. in Amer. Midl. Nat. **3** (1913) 123, in footnote.

*Triorchis vernalis* House, l. c., **6** (1920) 206.

*Triorchis xyridifolia* House, l. c.

*Spiranthes cernua* × *gracilis* Ames in Rhodora **23** (1921) 80, t. 128.

Roots several, thick, hirsute. Leaves quickly deciduous before anthesis of flowers, grassy, linear or linear-lanceolate, acutish, to 18 cm. long, about 1 cm. wide, rather conduplicate, merging into the large foliose bracts which extend to the floral-bearing portion. Stem erect, wiry, to 60 cm. high, bearing a single-ranked spike 14 cm. or more long which is mostly secund or laxly spiralled. Flowers highly variable in color, from white to greenish or yellowish, usually with more or less creamy-yellow lip, about 6 mm. long. Dorsal sepal connate with petals, oblanceolate and rather obtuse. Laterals spreading, similar to dorsal in shape, with introrse margins and somewhat involute apex, all sepals densely pubescent on outer surface. Petals connate with dorsal sepal over lip and column, upturned apically, oblanceolate, obtuse or somewhat truncate, often slightly introrse at apex. Lip about 6 mm. long, oval or broadly ovate, crenulate toward apex, somewhat revolute, with a curved blunt callus on each side of short basal claw, the disc with slight yellowish thickenings. Distinguished from closely allied *Spiranthes praecox* most easily by pubescence hairs of flower-spike, which are sharply or roundly pointed at apex, instead of capitate or furnished with small globular apical protuberance.

Peninsular Florida, where it is widespread and common. Also north to Massachusetts and west to New Mexico and Kansas. Flowers in the late winter and spring.

# A New Genus and New Records of Fresh-water Pyrrophyta in the Desmokontae and Dinophyceae

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Most of the organisms treated in the following report were collected from residual pools in stream beds, temporary and permanent oxbow waters, and small ponds in Kansas.

The first three organisms to be discussed, however, were collected in Maryland. Of these, *Exuviella compressa* (Stein) Ostenfeld and *Amphidinium klebsii* Kofoid et Swezy, were collected from the swampy end of a small pond on Drum point, near Solomons, Maryland. These are not new records for this country, having been reported from marine and brackish waters; but, they have not previously been reported from a fresh-water habitat.

The above mentioned pond is located on Drum point at the mouth of the Patuxant river. The overflow level of the pond is about two feet above the high tide level of the adjacent bay. In 1935, hurricane winds piled bay water over this area to a depth of two feet but there has been no recurrence of such a phenomenon since. Thirteen years later, in 1948, when collections of algae were made, there was no detectable salinity by taste, though chemical test showed a salinity of 1.0. At that time the two organisms, named above, were present in abundance in a surface bloom. An incomplete list of the other algae present shows that the algal flora of the pond and swamp is essentially a fresh-water flora. There were also present species of such fresh-water plants as *Utricularia*, *Myriophyllum*, *Ranunculus*, *Lemna*, *Wolffia*, *Chara*, and *Nitella*.

The following is an incomplete list of the algae present in Drum point pond.

## CHLOROPHYCEAE

*Chlamydomonas* spp.  
*Phacotus lenticularis*  
*Pandorina morum*  
*Eudorina elegans*  
*Gloeocystis gigas*  
*Oedogonium* spp.  
*Bulbochaete* spp.  
*Spirogyra* spp.  
*Zygnema* spp.  
*Oocystis parva*  
*Coronastrum ellipsoideum*  
*Chlorochytrium lemnae*  
*Cosmocladium saxorum*  
*Euastrum* spp.  
*Closterium* spp.  
*Cosmarium* spp.

## CHLOROMONADOPHYCEAE

*Gonyostomum semen*  
" *latum*

## CYANOPHYCEAE

*Chroococcus giganteus*  
" *turgidus*  
" *limneticus*  
*Aphanothece* spp.  
*Gloeotheca linearis*  
*Microcystis aeruginosa*  
*Coelosphaerium naegelianum*  
*Merismopedia elegans*  
" *punctata*  
*Gomphosphaeria aponina*  
" *lacustris*  
*Spirulina major*  
*Arthrospira jenneri*  
*Gloeotrichia echinulata*  
*Anabaena spiralis*  
*Oscillatoria* spp.  
*Lyngbya* spp.

## EUGLENOPHYCEAE

- Euglena acus*  
 " *truncata*  
 " *proxima*  
*Lepocynclis steinii*  
 " *fusiformis*  
 " *ovum*  
*Trachelomonas volvocina*  
 " *ovum*  
 " *horrida*  
*Phacus triqueter*  
 " *longicauda*  
 " *pyrum*

## CRYPTOPHYCEAE

- Cryptomonas erosa*  
 " *ovata*  
*Chroomonas nordstedtii*  
*Tetragonidium verrucatum*

## XANTHOPHYCEAE

- Peroniella curviceps*  
*Goniochloris sculpia*  
*Tetraedriella* spp.  
*Tetragoniella* spp.  
*Chlorobotrys regularis*  
*Monocilia simplex*

## DESMOKONTAE

- Exuviella compressa*

## DINOPHYCEAE

- Amphidinium klebsii*  
*Gymnodinium neglectum*  
 " spp.  
*Glenodinium quadridens*  
*Peridinium williei*  
*Tetradinium javanicum*

## EXUIELLA COMPRESSA (Stein) Ostenfeld (Figs. 10, 11)

This organism, though well known to students of marine Dinoflagellates, is less well known to students of the fresh-water forms. The protoplast is enclosed in a flattened, ellipsoidal test which is emarginate at the anterior end and broadly rounded at the posterior end. The test separates into two equal parts along a line of dehiscence that encircles it in the broadest diameter. The anterior depression is funnel-form with a small opening through which the two flagella are exerted. There are two deep green to pale yellow-green, parietal chromatophores, each with a large central pyrenoid. The chromatophores meet along the line of dehiscence of the test. The nucleus is large and posterior in position. There is no eyespot. Of the two flagella, one is directed forward and the other is whipped about, causing the cell to rotate on its long axis. At times the whipping flagellum trails and the cell glides along without any revolutions.

The cells of the specimens collected in Drum point swamp were slightly smaller than specimens of the same species collected from the Chesapeake bay. They varied from 22–26  $\mu$  long, 15–18  $\mu$  wide, and 11–12  $\mu$  thick.

## AMPHIDINIUM KLEBSII Kofoid and Swezy (Figs. 1–9)

This species was described from brackish waters. It is similar to *A. operculatum* Clap. et Lachm. but differs in shape of the epicone and

## EXPLANATION OF FIGS. 1–20

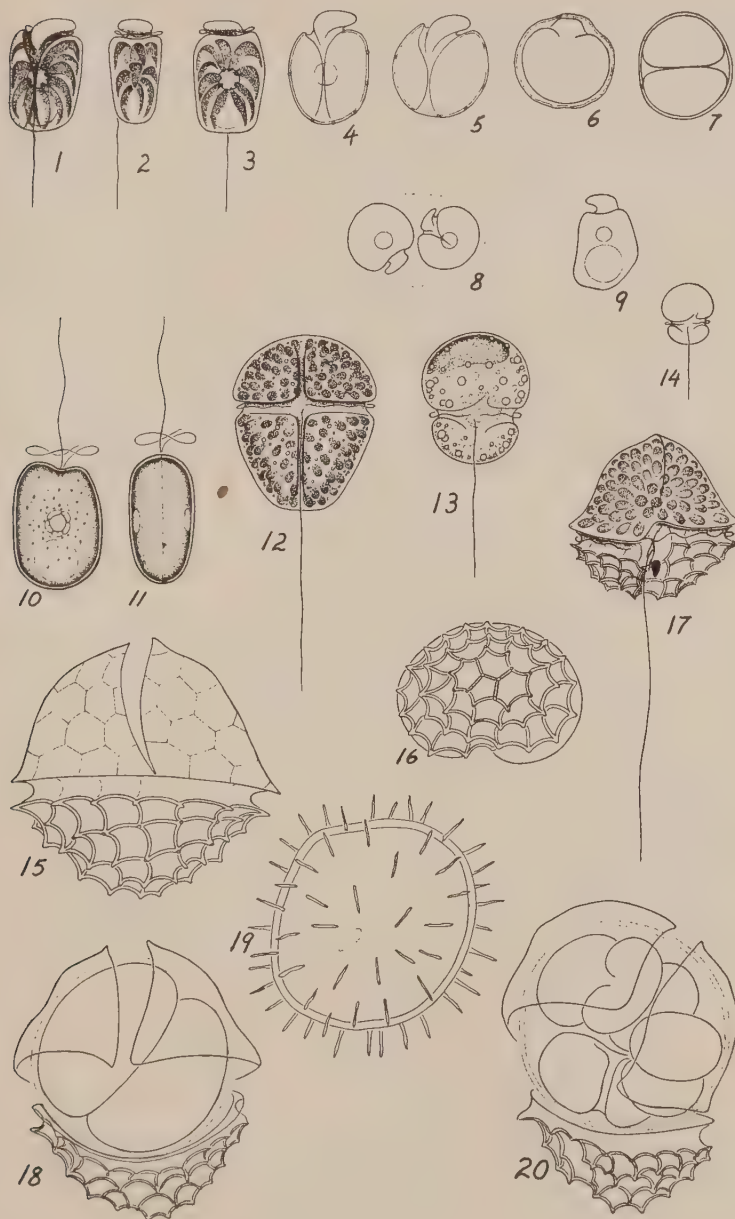
FIGS. 1–9. *Amphidinium klebsii* Kof. et Swezy,  $\times 808$ . 1–3. Ventral, lateral and dorsal views. 4. Lifted membrane showing suture (?) points. 5–9. Stages in cell division.

FIGS. 10–11. *Exuviella compressa* (Stein) Ostenfeld, face and side views,  $\times 808$ .

FIG. 12. *Gymnodinium aeruginosum* Stein, ventral view,  $\times 780$ .

FIGS. 13, 14. *Gymnodinium bohemicum* Fott, ventral view,  $\times 1560$ . 14. same,  $\times 780$ .

FIGS. 15–20. *Woloszynskia reticulata* Thompson, gen. et sp. nov.,  $\times 780$ . 15. Dorsal view of theca. 16. Hypotheca. 17. Ventral view of a young living cell. 18, 20. Stages in cell division. 19. Resting cyst in old theca.



in size. Cells are rounded-rectangular, but being somewhat plastic may assume a circular or disc-shape while swimming. There is a central pyrenoid from which radiate few to many strap-shaped, pale green chromatophores. The nucleus is large and posterior in position. There is no eyespot. The specimens collected in Drum point swamp were somewhat smaller than those of the same species collected from Chesapeake bay. They measured 18.6–22  $\mu$  long, 10–14  $\mu$  wide, and 7–10  $\mu$  thick.

This organism was abundant in a surface bloom and produced all stages in simple reproduction. The cells round up and the bounding membrane is lifted slightly. At this time it becomes suggestively evident that the outer covering, though plastic, is probably composed of definite plates. The evidence consists in the presence of a definite number of minute "beads," or small opacities, in the lifted membrane which always appear in the same relative position and which may be sutures as seen in optical section (Fig. 4). Further proof that the vestment is formed of plates and their arrangement was not possible since, as the cells swelled, the covering gelatinized and expanded. The protoplast then divided to form two daughter cells which escaped by a complete dissolution of the old mother vestment (Figs. 5–9).

#### GYMNODINIUM AERUGINOSUM Stein

(Fig. 12)

This species was collected during the summer of 1948 from a small Cypress swamp near Port Republic, Maryland. The cells are ovoid with a supramedian girdle and a sulcus that extends from one apex to the other. The epicone is broadly rounded to hemispherical in outline while the hypocone is rounded-conical. Cells of the Maryland specimens measured 20–32  $\mu$  long, and 13–25  $\mu$  wide. They are dorsoventrally flattened. The superior margin of the girdle overhangs the channel of the girdle appreciably. The chromatophores are small, numerous, and a brilliant blue-green. They are radially arranged at the periphery of the cell. An eyespot is lacking.

When division is to occur, the cell comes to rest and secretes a copious gelatinous matrix about itself. Two to four daughter cells are produced by divisions within this gel.

The remaining organisms to be discussed were collected in Kansas. All were taken with a plankton net and studied in both living and preserved condition. With the exception of *Glenodinium oculatum* Stein and *Massartia vorticella* (Stein) Schiller, they are all new records for the United States.

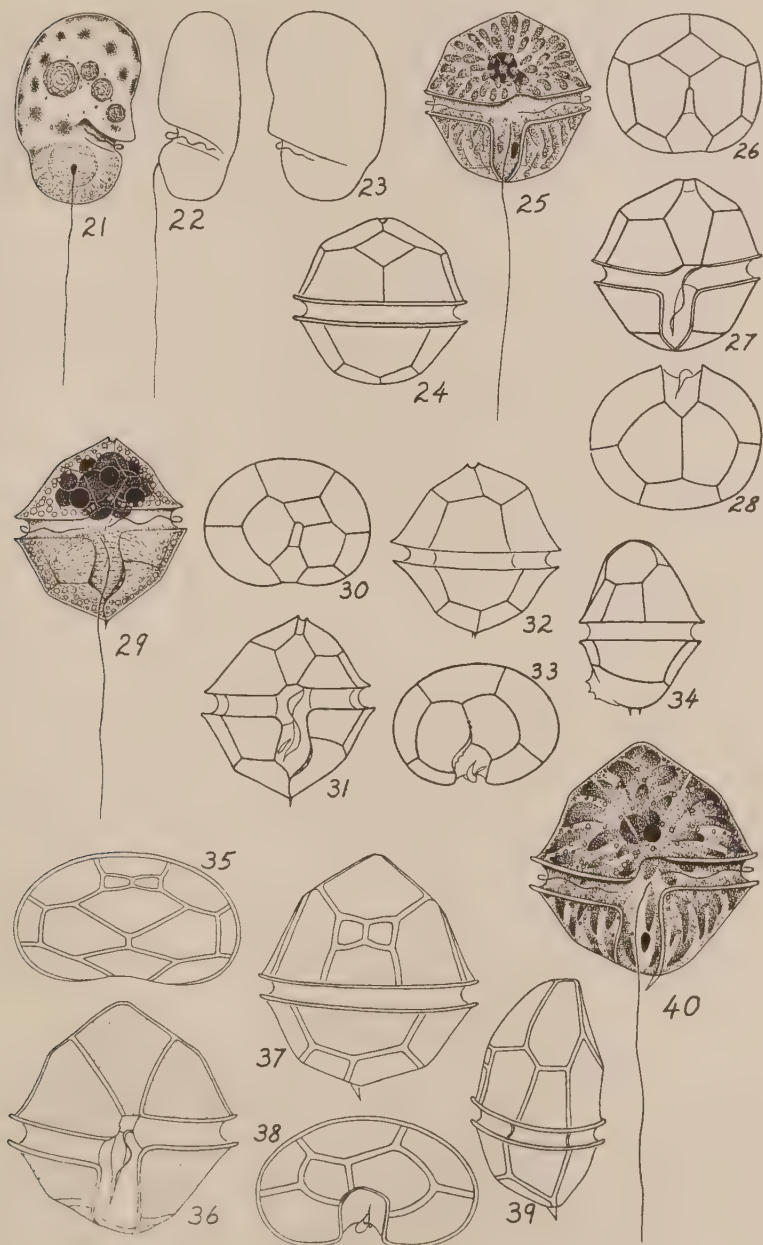
#### EXPLANATION OF FIGS. 21–40

FIGS. 21–23. *Bernardinium bernardinense* Chodat, ventral, lateral and dorsal views,  $\times 1560$ .

FIGS. 25–28. *Glenodinium kulczynskii* (Wolosz.) Schiller,  $\times 780$ . 25. Ventral view of living cell. 24, 26–28. Four views of the theca.

FIGS. 29–34. *Glenodinium berolinense* (Lemm.) Lindemann,  $\times 780$ . 29. Ventral view of a living cell. 30–33. Four views of the theca. 34. Left lateral view to show spinescent flange on the first antapical plate.

FIGS. 35–40. *Glenodinium gymnodinium* Penard var. *biscutelliforme* Thompson, var. nov.,  $\times 780$ . 35–38. Four views of the theca. 39. Right lateral view. 40. Ventral view of a living cell.



**GYMNODINIUM BOHEMICUM** Fott (1938) (Figs. 13, 14)

This minute species was described from Czechoslovakia where it was collected in August from a depth of 20 meters.

The cells are ovoid, 12–16  $\mu$  long with an inframedian girdle and broadly rounded poles. The chromatophores are discoidal, parietal, and number from two to eight. Numerous highly refractive granules are usually present at the periphery, but the cytoplasm is otherwise crystalline clear. The trailing flagellum is approximately equal to the cell in length.

Fott describes the chromatophores as brown. Those of the Kansas specimens were a pale yellow-green. These specimens were collected in a surface plankton tow taken on the fourth of March, 1950. The pond was just clearing from a cover of thin ice. The organism was apparently just appearing (five individuals only were seen) which probably accounts, along with the cold temperature of the water, for the lack of a characteristic pigmentation. The cold temperature probably also accounts for its presence in the surface plankton.

Cells of the Kansas specimens measured 10–11  $\mu$  long, the epicone 8–10  $\mu$  wide, and the hypocone 5.8–7  $\mu$  wide.

Collected March, 1950, Terrill's pond, Lawrence, Kansas.

**Gymnodinium cruciatum** sp. nov. (Figs. 103, 104)

Cellulae decoloratae, stigmatibus nullo, ovatae, 19–21  $\mu$  longae, 14–15.5  $\mu$  latae. Sulcus apice basin distentus.

Cells are colorless, without a stigma, ovoid, 19–21  $\mu$  long, and 14–15.5  $\mu$  wide. The sulcus extends from apex to apex.

The specific name refers to the cross formed by the elongate sulcus and the girdle as seen in ventral view.

This small, holozoic, species is apparently constant in the character of a sulcus which extends from apex to apex. The protoplasm is granular, gray, and usually contains many small refractive granules near the periphery and sometimes a few large food vacuoles in either the hypocone or epicone.

There is no other similar holozoic *Gymnodinium* species within the size range observed for this species. *G. austriacum* Schiller is similar in all respects, but is a very much larger form, being 40–41  $\mu$  long and 25–26  $\mu$  wide.

Collected July, 1950, Horseshoe Lake, Lawrence, Kansas.

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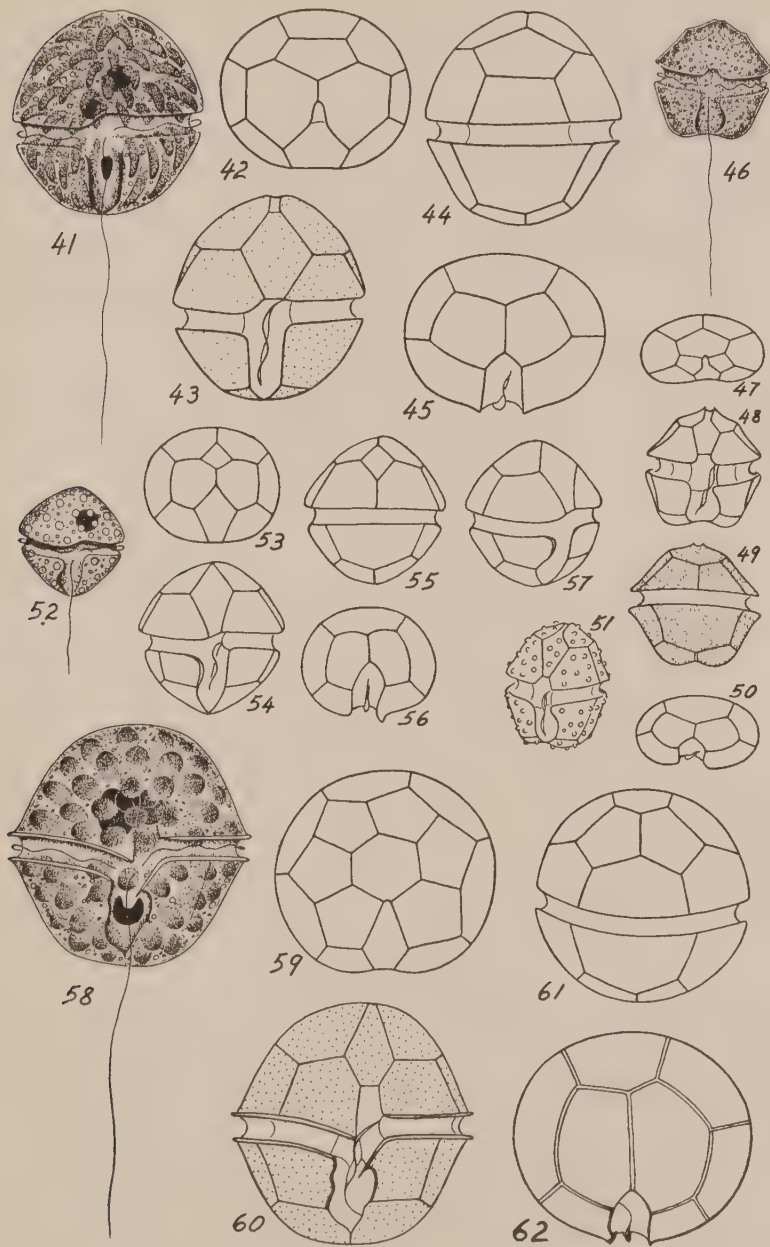
EXPLANATION OF FIGS. 41–62

FIGS. 41–45. *Glenodinium oculatum* Stein,  $\times 780$ . 41. Ventral view of a living cell. 42–45. Four views of the theca.

FIGS. 46–51. *Glenodinium penardiforme* (Lindem.) Schiller,  $\times 780$ . 46. Ventral aspect of a living cell. 47–50. Four views of the theca. 51. Individual with a papillate theca.

FIGS. 52–57. *Glenodinium edax* Schilling,  $\times 780$ . 52. Ventral view of a living cell. 53–57. Five views of the theca.

FIGS. 58–62. *Sphaerodinium polonicum* Wolosz.,  $\times 780$ . 58. Ventral view of a living cell. 59–62. Four views of the theca.



## MASSARTIA VORTICELLA (Stein) Schiller

(Figs. 94-99)

This is a holozoic species and frequently contains masses of ingested green algae or red, spherical, bodies of oil. Cells are ovoid with a conical or dome-shaped epicone that is twice as long as the small, rounded-conic to hemispherical hypocone. At the sulcus, the ends of the girdle are displaced one to one and one-half times its width, and rises on the left with the sulcus to form a sharp sinus in the epicone. The sulcus in the hypocone is a narrow channel and nearly reaches the antapex. The stigma lies in this portion of the sulcus and is bright red, and ovate to elongate in shape. The dimensions given in the literature are 23-24  $\mu$  long and 20-21  $\mu$  wide. The Kansas specimens varied from 21-33  $\mu$  long and 18-30  $\mu$  wide. The swimming cells of this collection changed shape while in motion and exhibited several forms that were retained for long periods. Something of the size range and different shapes is illustrated by the figures.

This report of *M. vorticella* is an additional record for the United States. The first is that of Prescott (1927) when it was reported from Iowa under the older name of *Gymnodinium vorticella* Stein.

Collected May, 1950, Old oxbow pond; July and August, Horseshoe Lake, Lawrence, Kansas.

## MASSARTIA TETRAGONOPS Harris (1940)

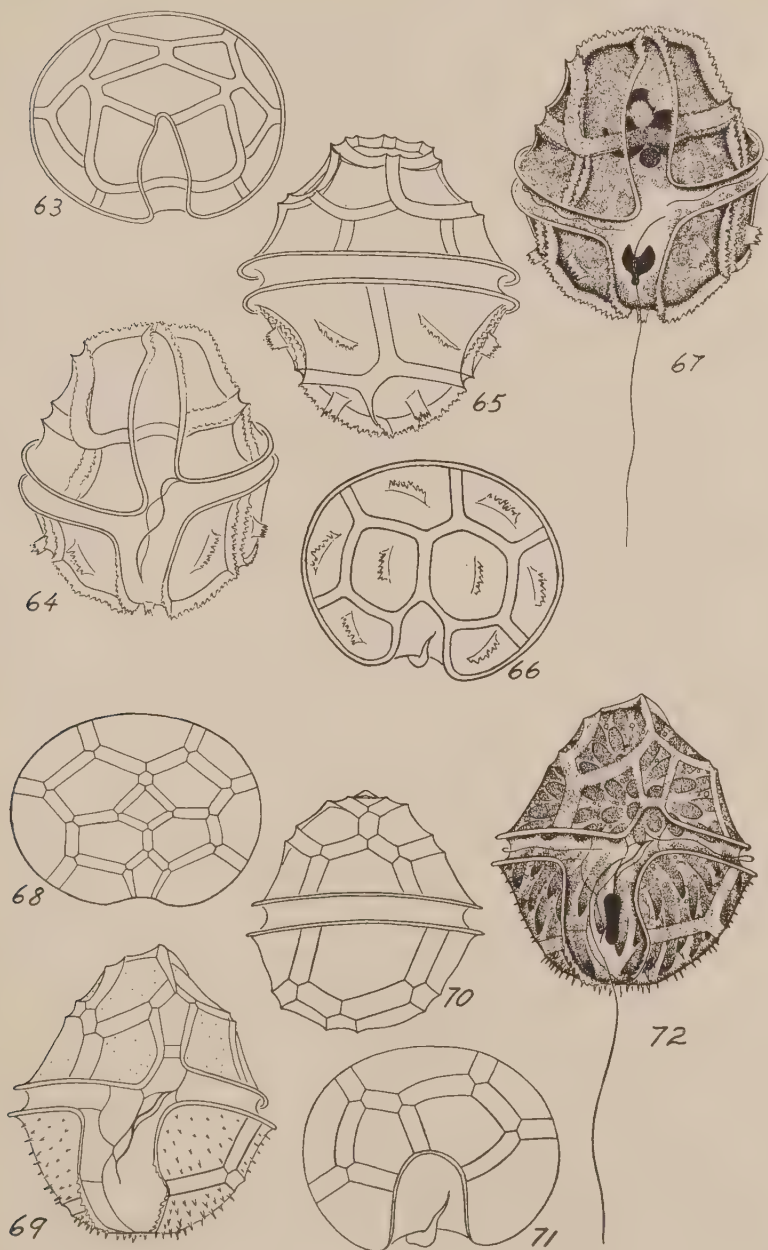
(Figs. 100-102)

This colorless holozoic species is smaller than *M. vorticella* and extremely active. The described measurements are 12.5-16.5  $\mu$  long and 12-16  $\mu$  wide. The Kansas specimens varied from 10-15  $\mu$  long and 7-12  $\mu$  wide. The girdle ends, adjacent to the sulcus, are displaced one and one-half to two times the girdle width. The sulcus forms a narrow straight channel to the antapex and a sharp sinus in the epicone. The living cells may change shape while in motion. The eyespot lies in the sulcus and appears square when the sulcus is narrowed, but is round or ovoid when the sulcus is broadened.

*M. tetragonops* has been previously known from England only where Harris reports it to be the "commonest of the holozoic *Gymnodiniaceae*."

Collected April, 1950, oxbow and ditch waters, Chanute, Kansas; and, May, oxbow swamp, near Lawrence, Kansas.

The genus *Gymnodinium* was erected to hold the non-thecate, or "naked" Dinoflagellates. Some of the early members of the genus were found to possess a theca composed of distinct plates; hence, were removed. According to Schiller (1933) and some recent papers, the genus now contains 83 species from marine and fresh-water habitats. Of these, seven species which are fresh-water organisms, have been shown to possess a theca composed of many small, usually hexagonal, plates. This discovery and our entire knowledge of these thecate forms is the work of Woloszynska (1916, 1917). Since this primitive kind of theca is delicate, somewhat plastic, and difficult to demonstrate the general reaction to her discovery has been to suspect that most species of *Gymnodinium* may be found to possess one. Kofoid (1921) states, however, that he has never seen a multiplate theca on any of the marine species of *Gymnodinium*.



FIGS. 63-67. *Sphaerodinium fimbriatum* Thompson, sp. nov.,  $\times 780$ . 63-66. Four views of the theca. 67. Ventral aspect of a living cell.

FIGS. 68-72. *Peridinium palatinum* Lauterborn,  $\times 780$ . 68-71. Four views of the theca. 72. Ventral aspect of a living cell.

The presence of a theca can be demonstrated without actually seeing the plates. One method involves rapid killing of the cell with the fumes from crystalline iodine. If a theca is present, the protoplast shrinks away from it without loss of shape. The theca appears as a glistening membrane in which, in profile, the sutures appear as bead-like thickenings or opacities.

Unless all species of *Gymnodinium* can be shown to have a theca, the possession of such by any species makes its presence in the genus untenable.

When one examines our knowledge of the genus as a whole there appears sufficient evidence for the view that many species most probably are non-thecate and too that the greater number of these are marine organisms.

Among the fresh-water species, *G. fuscum* Stein, when treated with iodine fumes does not show a membrane such as that described earlier. Instead the cell as a whole shrinks irregularly with a total loss of its characteristic shape. When *G. fuscum* divides it also illustrates the fact that it does not possess a theca. Division of the cell starts while it is still motile. The first external indication is an elongation and broadening of the antapex which then splits. Fission continues apically with the cell coming to rest when the girdle becomes involved. Movements continue, however, and the two new hypocones contract and expand. When fission is nearly complete but with a portion of the two developing epicones still attached the daughter cells have independent flagellation and swimming activity may be resumed. Both girdle and sulcus are formed on the new individuals as fission progresses. Kofoid (1921) described division of a marine species, *G. heterostriatum* Kof., in which the striated periplast is formed on the new surfaces concurrently with fission.

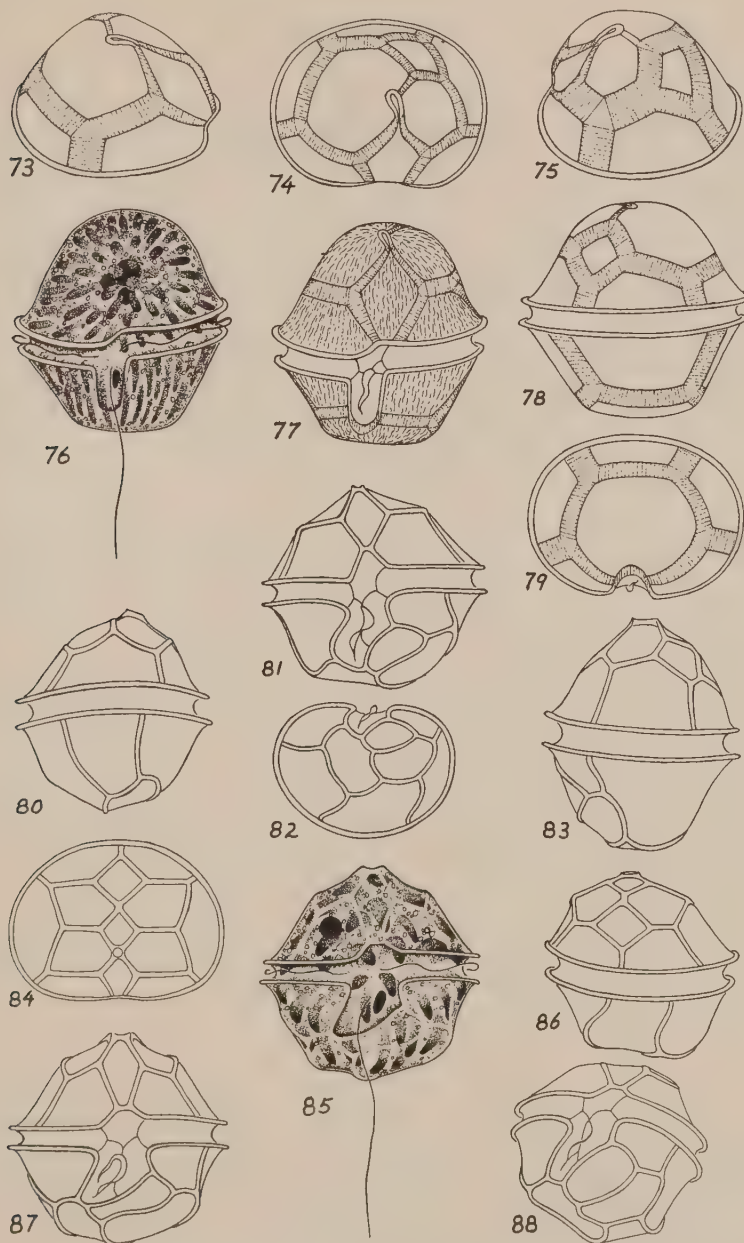
In contrast to the above, thecate Dinoflagellates come to rest before fission. The protoplast may escape from the theca and divide or it may secrete a wall within the theca and divide within the new wall. Sometimes there is division within the theca and a separating of the theca such that the two new cells each receive a portion of the parent theca. It is the observation of the writer that those species of *Gymnodinium* for which a theca can be demonstrated likewise come to rest before fission and also secrete a "division cyst" wall.

Two fresh-water species of *Gymnodinium* have been described with striae of the kind known for many marine species. The marine species so ornamented would seem to have a tough periplast rather than a cellulose theca.

From the foregoing facts and to preserve the connotation of the generic name those species of *Gymnodinium* known to have a definite theca should be removed from the genus. Since the number and arrangement of the plates is unlike that of any other Dinoflagellate, a new genus should be erected to receive them. Such a genus is now described, and a new species added to those which are to be transferred.

### **Woloszynskia** gen. nov.

Cellulae characteres typicos dinoflagellatarum exhibentes. Cingulum rectum vel spiratum. Sulcus hypocono intercalatus et epiconum haud



FIGS. 73-79. *Glenodinium ambiguum* Thompson, sp. nov.,  $\times 780$ . 73-75. Right, apical and left views of epitheca. 76. Ventral view of a living cell. 77, 78. Ventral and dorsal views of the theca. 79. Hypotheca.

FIGS. 80-88. *Peridinium intermedium* Thompson, sp. nov.,  $\times 780$ . 80, 81, 83. Right, ventral and left views of theca. 82, 84. Hypotheca and epitheca. 85. Ventral view of a living cell. 86-88. Dorsal and two ventral views of theca.

multum intrusus. Cellulae theca delicata plastica multis (plerumque sexangularibus) scutellis composita vestitae.

The cells have the characters typical of the Dinoflagellates. The girdle is straight or spiraled. The sulcus is in the hypocone and enters the epicone but little. The cells are enclosed in a delicate, plastic theca which consists of many (usually hexagonal) plates.

**W. reticulata** sp. nov.

(Figs. 15-20)

Cellulae in conspectu ventrali rhomboideo-ovatae, 25-52  $\mu$  longae, 21-46  $\mu$  latae, dorsoventraliter compressae. Cingulum inframedium. Chromatophori fulvi. Stigma obovatum, sulco inclusum. Flagellum posticum cellula 1-1½ longius.

Epitheca delicata, levis, campanulata, carina a ventrali margine ad dorsalem marginem apice excurrenti, fragili. Scutellae epithecae 4-5-seriatae. Hypotheca hemisphaerica, 4-seriatis scutellis levibus, crassis, concavis composita. Scutellae 19 postcingulares, 14 postintercalares, 9 antapicales intercalares, et 4 antapicales.

Type material, no. 4975, in the author's herbarium, preserved in formalin.

Cells rhomboid-ovoid in ventral view, 25-52  $\mu$  long, 21-46  $\mu$  wide and dorsoventrally flattened. The girdle is inframedian (median in old cells). Chromatophores are yellow-brown. The obovate or V-shaped stigma is in the sulcus. The trailing flagellum is 1-1½ times the cell length.

The epitheca is delicate, smooth and bell-shaped with a carina over the apex from the ventral to the dorsal margin of the girdle. Splitting of the theca occurs along this line as well as around the girdle. The plates of the epitheca are in four or five series.

The hypotheca is hemispherical and is composed of four series of smooth, thick, concave, plates. The plates are distributed as 19 postcingular, 14 postintercalary, 9 antapical intercalary, and 4 antapical groups. There is some variability in this grouping but the above distribution seems to be the more common. It is interesting to note that the increment of increase in number of plates in each tier from antapex to girdle is five plates. The most common variation observed is that of 20 postcingular and 3 antapical plates. The plates forming the sulcus are curved inward more deeply than the surrounding plates, thus producing a continuous channel.

#### EXPLANATION OF FIGS. 63-72

FIGS. 89-93. *Peridinium godlewskii* Wolosz.,  $\times 780$ . 89. Ventral aspect of a living cell. 90-93. Four views of the theca.

FIGS. 94-99. *Massartia vorticella* Stein,  $\times 780$ . 94-98. Ventral aspect of different individuals. 99. Ventral aspect of a living cell.

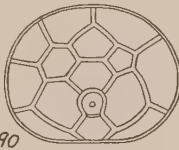
FIGS. 100-102. *Massartia tetragonops* Harris. 100. Ventral aspect of a living cell,  $\times 1560$ . 101, 102. Ventral views,  $\times 780$ .

FIGS. 103-104. *Gymnodinium cruciatum* Thompson, sp. nov. 103.  $\times 780$ . 104. Same individual,  $\times 1560$ .

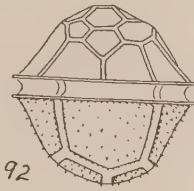
FIGS. 105-109. *Woloszynskia coronata* (Wolosz.) Thompson, nov. comb.,  $\times 780$ . 105. Ventral view of a living cell. 106, 108. Extremes in size, 108 being a newly produced cell. 107. Empty theca showing plates on dorsal side. 109. Four daughter cells within "division cyst."



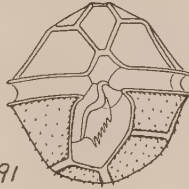
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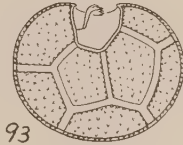
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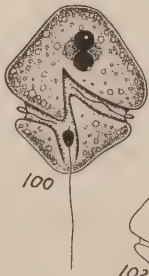
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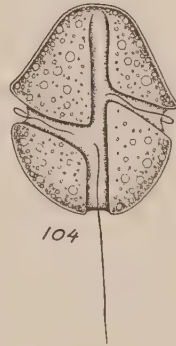
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102



105



106



107



108



109

The first visible indication of reproduction is the longitudinal splitting of the stigma. At this time many adult-sized cells will have a V-shaped stigma. The protoplast may escape from the theca, by a splitting along the carina and the girdle, and encyst, or it may produce a smooth-walled cyst within the theca. Within this new wall the protoplast divides to form two or four daughter cells which escape by a dissolution of the retaining membrane (Fig. 18, 20).

Resistant cysts are formed, usually within the theca, and are either spherical or slightly rhomboid. They are spinescent looking, the "spines" being in reality the platelets which, while remaining attached along one margin, are opened outward so that they stand at right angles to the periphery of the cyst wall. The edge view of these plates gives the appearance of numerous blunt spines (Fig. 19).

Collected August, 1949, Horseshoe Lake, Lawrence, Kansas; June, 1950, oxbow pond, North Lawrence; July, 1950, Neosho river oxbow, Chanute, Kansas; August, 1950, Hayden's pond and adjacent oxbow, Lawrence, Kansas.

The following are the new combinations necessary to effect the transfer of those species of *Gymnodinium* known to possess a theca.

**W. tenuissima** (Lauterborn), nov. comb.

(= *Gymnodinium tenuissimum* Lauterborn)

**W. heimale** (Woloszynska), nov. comb.

(= *Gymnodinium heimale* Wolosz.)

**W. leopoliensis** (Woloszynska), nov. comb.

(= *Gymnodinium leopoliense* Wolosz.)

**W. vera** (Lindemann), nov. comb.

(= *Gymnodinium veris* Lindem.)

(= *Gymnodinium carinatum* Schilling var. *heimale* Wolosz.)

**W. polonica** (Woloszynska), nov. comb.

(= *Gymnodinium polonicum* (Wolosz.) Wolosz.)

(= *Glenodinium polonicum* Wolosz.)

**W. neglecta** (Schilling), nov. comb.

(= *Gymnodinium neglectum* (Schilling) Lindemann)

(= *Glenodinium neglectum* Schilling)

This species has been reported from Maryland (Thompson, 1947) and has been collected more recently from both Chanute and Lawrence, Kansas, in July, 1950.

**W. coronata** (Woloszynska), nov. comb.

(Figs. 105-109)

(= *Gymnodinium coronatum* Wolosz.)

Cells of this species are nearly spherical, the epicone often being slightly conical, with a median girdle and a shallow sulcus in the hypcone. Chromatophores are light to dark brown. The stigma is bright red and may be broadly lunate (predivision condition?) or discoidal in shape. Woloszynska (1917) gives its dimensions as up to 30  $\mu$  long, and up to 25  $\mu$  wide. The Kansas specimens varied from 19-35  $\mu$  long, and 14-32  $\mu$  wide, the lower limits being the dimensions of newly formed daughter cells.

The theca is discarded soon after collection of the organism and usually appears clear and structureless except for the girdle and one or two short striae in the sulcus. The cell usually emerges from the theca through the apex and in doing so destroys the apical plates, but leaves the shape and margins of the adjacent plates clearly evident. Sometimes there is considerable swelling and broadening of the sutures before emergence. On such a discarded theca one can readily discern the numerous small plates. Most of the plates are hexagonal and of approximately the same size. On the hypotheca, however, the first series of intercalary plates, the postintercalary, are elongate and radiate from the antapical group of plates. Woloszynska illustrated several hypothecas of this kind, but also depicted one in which the position of such elongate plates was taken up by two series of hexagonal plates. On none of the thecas examined was there a clearly discernable punctate antapical plate, though one specimen bore a plate suggestive of punctation. This material then, might be identified as *W. coronata* var. *glabra* Wolosz. if one gives that much significance to the absence of an antapical punctate plate. The Kansas specimens also exhibited some variability in the number and shape of the hypothecal plates, but not to the extent that Woloszynska found.

Collected July, 1950, Old oxbow pond, Chanute, Kansas; August, 1950, Lone Star Lake, Lone Star, Kansas.

To these should be added two other species for which there is evidence of a theca (Thompson, 1947) though a complete picturization of the theca has not been obtained.

**W. ordinata** (Skuja), nov. comb.

(=*Gymnodinium ordinatum* Skuja)

**W. cestocoetes** (Thompson), nov. comb.

(=*Gymnodinium cestocoetes* Thompson)

**BERNARDINIUM BERNARDINENSE** Chodat (1923)

(Figs. 21-23)

This organism has not been reported since the original description when it was found near Grand St. Bernard, Switzerland, by Chodat.

The cells are ovoid with an incomplete girdle which describes a downward left handed spiral about the posterior one-third of the cell. On the ventral side the girdle curves sharply anteriorly and terminates abruptly in a very brief suggestion of a sulcus. The girdle becomes dissipated on the dorsal side, but a shallow groove may extend on and produce an indentation in the right side of the cell.

The transverse flagellum does not completely encircle the cell. The trailing flagellum issues from a minute pore in the posterior ventral part of the cell and is approximately equal in length to the cell. There is no eyespot, though the flagellar pore gives the effect of one since its sharp margins and depth produce the appearance of a dark spot at that point.

The hypocone is colorless and hemispherical in profile. It contains a row of small vacuoles paralleling the posterior margin. These were not observed to contract.

The epicone is ellipsoidal, about two to two and one-half times as long as the hypocone and characteristically has an indentation in its left side. The nucleus is large, spherical, and posterior in position.

*B. bernardinense* is described as colorless. One of the Kansas specimens was colorless, but did contain three large, yellow to brown, roughly spherical masses in the epicone. In the other cells the epicone contained, as well as such colored masses, many small, diffuse, parietal, very pale yellow-green chromatophores.

Insufficient material was at hand to attempt an investigation for the presence of a theca. Other than the rigidity of the cell and sharpness of the girdle margins there was nothing to suggest the presence of a theca.

Chodat gave the dimensions of *B. bernardinense* as 16.8–19  $\mu$  long, and 13.2–14  $\mu$  wide. The Kansas specimens measured 15–17  $\mu$  long and 10–12  $\mu$  wide. They were dorsoventrally flattened but an accurate measurement of this diameter was not obtained.

Unfortunately the rediscovery of this organism has added nothing to show its affinities. The disproportion between epicone and hypocone might suggest the genus *Massartia*, but the incomplete girdle is a character of the genus *Hemidinium*. It is unlike *Hemidinium* in that the girdle is located near the posterior end. Yet, until it is known to possess a theca, and the structure of that theca, only on the basis of its semigirdle and rigidity of form can it be placed near *Hemidinium* in the *Glenodiniopsidaceae*.

The only other organism that approaches *B. bernardinense* in appearance is *Massartia hyperxanthoides* Harris (1940). In cell shape and size (Harris gives only the length, 15  $\mu$  the latter is similar to *B. bernardinense*. It differs in having a complete girdle, a narrow sulcus which ascends obliquely into the epicone and then spirals down the dorsal side almost to the girdle, a small stigma, and two pale yellow chromatophores.

*B. bernardinense* was collected in August and October, 1949, from a residual pool in a stream tributary to Lake Fagen, Woodson Co., Kansas.

GLENODINIUM KULCZYNSKII (Wolosz.) Schiller (1937) (Figs. 24–28)

Cells of this species are nearly spherical. On the living cell very little can be determined about the plates in the theca, but the margins of the girdle and sulcus are conspicuous as rounded glistening rims. The dimensions given in the literature are 35  $\mu$  long and 30  $\mu$  wide. The Kansas specimens measured 28–48  $\mu$  long, and 23–36  $\mu$  wide. The chromatophores are yellow-brown and parietal but radiate in orientation. The stigma is small, obovoid to rod-shaped and lies in the sulcus. The plate formula is 4<sup>1</sup>, Oa, 6<sup>11</sup>, 5<sup>111</sup>, 2<sup>1111</sup>.

The distinguishing character of this species is the rhomboidal to square third apical plate. The cell shape, lack of antapical spines and larger size distinguish it from *Gl. berolinense*, as well as the lack of chromatophores in the latter species.

Woloszynska (1916) depicts a ventral view of this species showing the sulcus broadening antapically and the antapex as slightly swollen. In the Kansas specimens, cells that had come to rest and begun shedding the theca often showed the same widening of sulcus and antapical bulge.

Collected August, 1949, Horseshoe lake, Lawrence, Kansas; September, 1949, Petrolia, Kansas; and, June, 1950, Elk's lake, Chanute, Kansas.

*Glenodinium berolinense* (Lemmermann) Lindemann (Figs. 29-34)

This species has no eyespot and is without chromatophores though spherical colorless or pigmented masses may be present. The cytoplasm is granular appearing, particularly at the periphery where there are usually numerous, colorless, highly refractive, granules. The nucleus is ellipsoidal, conspicuously large, and may fill the entire posterior half of the cell. The cells are rhomboid-ovoid in ventral or dorsal view and may bear one or two minute spines at the antapex.

The epitheca is composed of four apical and six precingular plates. A distinguishing character is the inequality in size between the second and fourth apical plates. The latter is the larger (Fig. 30). This inequality forces the third apical plate into an excentric position and produces the characteristic "lop-sided" appearance of the cell in ventral or dorsal view (Figs. 31, 32). The hypotheca contains five postcingular and two antapical plates. Where it adjoins the posterior portion of the sulcus, the margin of the first antapical plate projects as a thin flange. On the edge of the flange are two or three small but distinct teeth (Fig. 34). The antapical spines, when present, are borne along the common suture between the two antapical plates.

On young cells of *Gl. berolinense* the girdle is equatorial or even inframedian. As the cell grows most of the increase in size is made in the posterior half so that the hypotheca becomes greatly distended. The girdle then has the apparent condition of being supramedian.

The dimensions given in the literature are 25-35  $\mu$  long, and 20-30  $\mu$  wide. The Kansas specimens varied from 30-37  $\mu$  long, and 29-32  $\mu$  wide. The cells are slightly flattened dorsoventrally.

Collected September, 1949, Horseshoe lake; October and December, 1949, Hayden's pond; February, 1950, Potter's lake; March, 1950, Old oxbow pool; July, 1950, Lone Star Lake; all near Lawrence, Kansas. The organism reached bloom proportions in October, in Hayden's pond.

*Glenodinium gymnodinium* Penard var. *biscutelliforme* var. nov. (Figs. 35-40)

Cellulae rhomboideo-ovatae, 33-54  $\mu$  longae, 30-51  $\mu$  latae, spina anguste triangulaei antapicali praedite. Stigma obovatum, sulco immersum. Epitheca scutellis duabus anterioribus intercalaribus decorata. Cellulae aliter characteres speciei exhibentes.

Cells are rhomboid-ovoid, 33-54  $\mu$  long, 30-51  $\mu$  wide, with a narrowly triangular spine on the antapex. The obovate stigma is in the sulcus. The epitheca contains two anterior intercalary plates. The cells, otherwise, have the characters of the species.

Collected August, September, October, 1949, Horseshoe lake, Lawrence, Kansas. Type material, no 4975, in the author's herbarium, preserved in formalin.

In shape this variety is more like the original figures of the species made by Penard. Except for the constant character of two small, adjacent, anterior intercalary plates on the dorsal side, the plate formula is the same as that for the species. Tafall (1941) describes and figures the same condition of two anterior intercalary plates on specimens he collected in Mexico. The plate formula 4', 1a, 7'', 5''', 2''', now accepted for the species, was worked out by Woloszyńska for *Peridinium*

*polonicum* Wolosz. (1916), a species which was subsequently reduced to synonymy with *Gl. gymnodinium*. Specimens typical of the species were reported for the United States by Eddy (1930).

The theca of the new variety is striately punctate to finely scrobiculate. Where the theca of most species of armored dinoflagellates separates at the girdle, when the protoplast escapes, that of the variety more frequently separates longitudinally into ventral and dorsal halves. This separation involves lateral sutures such that the ventral part is composed of the first apical, first and seventh precingular, the ventral girdle portion and sulcus, and the first and fifth postcingular plates. The dorsal part contains the remaining plates and the dorsal part of the girdle.

The antapical, narrow, wedge-shaped spine is more often present than absent. It is borne at the sulcus margin on the first antapical plate.

The stigma is small and a very pale orange. The fact that none is reported for the species may or may not be significant. Small, pale, eyespots are easily overlooked and a species may readily be described, in error, as lacking such a structure.

The majority of specimens varied in size from 33–44  $\mu$  long and 30–41  $\mu$  wide. In July, 1950, however, a "giant" form was collected near Chanute, Kansas, which measured 51–54  $\mu$  long, and 50–51  $\mu$  wide. The antapical spine was present or absent on these, but all intact thecas observed had two adjacent anterior intercalary plates.

#### ***Glenodinium ambiguum* sp. nov.**

(Figs. 73–79)

Cellulae ovatae aut sphaericae, 32–40  $\mu$  longae, 32–40  $\mu$  latae, 27–31  $\mu$  crassae. Chromatophori brunnei. Stigma oblongeolatum, rubrum. Theca levis, punctata vel irregulariter striata. Suturae striatae. Scutellae 4', 0a, 5'', 5''', 1'''' dispositae.

Cells ovate to spherical, 32–40  $\mu$  long, 32–40  $\mu$  wide, and 27–31  $\mu$  thick. Chromatophores are dark brown. The stigma is oblongeolate and bright red. The theca is smooth, punctate or irregularly striated. The sutures are striated. The plate formula is 4', 0a, 5'', 5''', 1''''.

This species is unlike any other described species of Dinoflagellate. It is characterized by the inequality in size between the second and fourth apical plates, with the consequent excentric position of the rhomboidal to square third apical plate; and, by having one antapical plate only. The first apical plate varies from narrowly to broadly rhomboidal in shape. On the living cell the only evident theca characters are the rounded, glistening rims of the girdle and narrow, straight, sulcus.

Collected July, 1950, Elm creek, Iola, Kansas; July, 1950, Old oxbow pool, Lawrence, Kansas; and, Horseshoe lake, Lawrence, Kansas.

Type material, no. 5054, in the author's herbarium, preserved in formalin.

#### **GLENODINIUM OCULATUM Stein**

(Figs. 41–45)

Cells are ovoid and slightly dorsoventrally flattened. The girdle is nearly median and slightly spiraled to the left. Chromatophores are yellow-brown and parietal. The stigma is small, rod-shaped, and

lies in the sulcus. On the living cell nothing can be determined concerning the theca, but the organism usually will cast off its theca within one or two hours after collection. The theca formula is  $4'$ ,  $0a$ ,  $7''$ ,  $5'''$ ,  $2''''$ . The third apical plate is characteristically five-sided. Two other species have this character, *Gl. elpatiewskyi* and *Gl. pygmaeum*. *Gl. oculatum* is easily distinguished from these by the fact that it bears no spines and by the median rather than inframedian girdle.

The theca of the Kansas specimens is smooth or very minutely punctate.

The dimensions given in the literature are 20–23  $\mu$  long. The Kansas specimens measured 23–36  $\mu$  long, and 21–36  $\mu$  wide.

The only previous record for this species in the United States is that of the writer (1938) from the same vicinity. The reasons for including the species in this report are that a greater abundance of material was available, allowing for a complete illustration of the theca, and that the punctuation of the theca plates had previously not been observed.

An interesting observation was made regarding the activity of a discarded girdle flagellum. After being completely detached the flagellum squirmed and writhed for 32 seconds before becoming quiescent.

Collected August, 1949, Horseshoe lake, Lawrence, Kansas; and, from the same place in March, 1950.

**GLENODINIUM PENARDIFORME** (Lindemann) Schiller (Figs. 46–51)

This species lacks an eyespot and chromatophores, but contains a dark granular appearing protoplasm so that it is somewhat fuscus or smoky-gray in color. Numerous, highly refractive granules may or may not be present at the periphery of the cell. The most immediately noticeable characters are the wide, deep, median, girdle and the broad, deep, sulcus which extends to the antapex. Here the sulcus produces a very marked concavity in the profile of the antapex. The cells are strongly, dorsoventrally flattened. The plate formula is  $4'$ ,  $0a$ ,  $6''$ ,  $5'''$ ,  $2''''$ . The plates may be smooth, or striately punctate or minutely scrobiculate. One specimen was seen which was embellished with a scattering of verrucae (Fig. 51).

Cells of the Kansas specimens measured 17–25  $\mu$  long, 17–23  $\mu$  wide, and 9–11  $\mu$  thick. This is smaller than the dimensions given in the literature which are 30–34  $\mu$  long, and 26–30  $\mu$  wide. The Kansas individuals differed only in size from the dimensions given in the published description of the species.

Collected August, 1949, Blue river, Stanley, Kansas, and below Fall river dam, Fall River, Kansas; September, 1949, from a small stream, Petrolia, Kansas; June, 1950, Chanute, Kansas; July and August, Green's pond, Lawrence, Kansas.

**GLENODINIUM EDAX** Schilling (1891) (Figs. 52–57)

Cells are spherical, 14.8–27.5  $\mu$  long, and 12–24.4  $\mu$  wide. The girdle is median or inframedian, slightly spiraled to the left. The sulcus is developed in the hypotheca only. Chromatophores and eyespot are lacking. The cytoplasm is coarsely granular and contains many refractive bodies at the periphery. The nucleus is large, ellipsoid, and posterior in position.

The plate formula is 4', 0a, 6'', 5''', 2'''''. The third apical plate is rhomboidal to diamond-shaped. The fifth postcingular plate is often developed along the sulcus margin as a slightly projecting flange.

The only dimensions given by Schilling for *Gl. edax* are 34  $\mu$  in length and 33  $\mu$  in width. The girdle is described and figured as inframedian. The plate formula was previously unknown. There is but one feature of *Gl. edax*, which Schilling described and figured, that separates it from the other colorless species of *Glenodinium*, namely, the flange-like extension of the fifth postcingular plate at the right hand margin of the sulcus. This is the only character by which the Kansas material can be identified with *Gl. edax*. The variability in position of the girdle is not a serious discrepancy, as it results from the same posterior growth or enlargement as that seen in *Gl. berolinense*. Since Schilling gave only the dimensions for one (?) individual, the Kansas specimens show the range in size as well as the plate formula.

Living cells of *Gl. edax* are easily distinguished from those of *Gl. kulczynskii* by the lack of chromatophores and eyespot in the former. The thecas of the two are separated by the projecting fifth postcingular plate, and relatively smaller size of the third apical plate of *Gl. edax*. From *Gl. berolinense* differentiation is made by the oppositely projecting plates of the two species, the symmetric apical plates of *Gl. edax* as contrasted to the excentric arrangement of the same group in *Gl. berolinense*, and the absence of spines in *Gl. edax*.

Collected March and April, 1950, Horseshoe lake, Lawrence, Kansas.

**SPHAERODINIUM POLONICUM** Woloszynska (1916) (Figs. 58-62)

Cells are nearly spherical with a median girdle that is slightly spiraled to the left. The sulcus extends into the epitheca and incompletely to the antapex. The sulcus margins in the hypotheca are irregular. Chromatophores are yellow-brown, numerous, and parietal and radiate in orientation. The eyespot, which lies in the sulcus, is very large and lunate to U-shaped.

The plate formula is 4', 4a, 7'', 6''', 2'''''. The third apical plate is characteristically hexagonal. The second and fourth apical and the four anterior intercalary plates are pentagonal and equal, or nearly so, in size and shape. The theca is usually finely punctate, but newly formed thecas are smooth. Along a portion of the sulcus margin, the first postcingular plate characteristically bears a flange-like thickening which terminates in a posteriorly directed spine-like process.

The dimensions given in the literature are 25-45  $\mu$  long and the width about the same. The Kansas specimens measured 38-45  $\mu$  long, and 37-42  $\mu$  wide.

*S. polonicum* is similar to *S. cinctum* (Ehrenberg) Wolosz., but the theca of the latter species is not punctate and there is scarcely any development of a spine-like process on the sulcus margin.

Collected July, 1949, Old oxbow pool; August, 1949, Horseshoe lake; July and August, 1950, Hayden's pond, and Green's pond, Lawrence, Kansas.

**Sphaerodinium fimbriatum** sp. nov. (Figs. 63-67)

Cellulae ovatae vel ellipticae, 42-53  $\mu$  longae, 42-46  $\mu$  latae. Chromatophori fusco-lutei. Stigma peramplum, calceolatum, frequenter lobo posteriore, sulco immersum. Cingulum medium. Scutellae 4', 4a,

7", 6"', 2'''' dispositae. Omnes hypothecae scutellae mediam costam fimbriatam gerentes. Margines suturarum productae fimbriatae.

Cells are ovate to elliptic, 42–53  $\mu$  long, and 42–46  $\mu$  wide. The chromatophores are a deep yellow-brown. The large stigma is horse-shoe-shaped, often with a posterior lobe, and lies in the sulcus. The girdle is median. The plate formula is 4', 4a, 7", 6"', 2'''''. Each plate in the hypotheca possesses a median fimbriate costa. The projecting margins of the sutures are also fimbriate.

Collected August, 1949, from one intermittent and one permanent oxbow, Horseshoe lake, Lawrence, Kansas. Type material no. 4970, in the author's herbarium, preserved in formalin.

Two characters are immediately noticeable on living cells of this species. The first is the "burr-like" appearance that is due to the raised, fimbriate margins of the sutures and costae. The second is the prominence of the second and fourth apical plates which completely flank the first apical plate on their respective sides. This feature is not duplicated by any other member of the *Peridiniaceae*. The hexagonal third apical plate and the four, nearly isodiametric, anterior intercalary plates, along with the presence of six postcingular plates characterizes this as a member of the genus *Sphaerodinium*.

Other collections have been made in July and August, 1950, from Horseshoe lake, Lawrence, Kansas.

#### PERIDINIUM PALATINUM Lauterborn

(Fig. 68–72)

Cells are ovoid with a median girdle that is slightly spiraled to the left. The sulcus is very broad in the hypotheca and enters narrowly and obliquely into the epitheca. The sutures are prominent, thick and unstriated. The plate formula is 4', 2a, 7", 5"', 2'''''. The hypotheca bears few to many slender prickles. They are more numerous along the sutures and on the two antapical plates. Elsewhere the theca may be smooth or finely punctate.

The Kansas specimens more nearly fit the characterization of *P. laeve* Huitf.-Kass, which was reduced to *P. palatinum* (Schiller, 1937). The first and third apical plates are small in comparison to the second and fourth. The third apical plate is unequally diamond-shaped. The shape of the intercalary and apical plates is variable, consequently not always as symmetric as shown in Fig. 68.

The Kansas specimens also possessed an eyespot, a structure not previously recorded for the species. It is very thin, ovate to spatulate in shape, and pale orange to scarlet in color.

The only dimensions given in the literature are for a length of 40–50  $\mu$ . The Kansas specimens varied from 34–53  $\mu$  long, and 28–46  $\mu$  wide. The cells are slightly dorsoventrally compressed.

Smooth-walled resting cysts are formed within the theca. When the motile cell is ready to divide it comes to rest during mitosis; then before cytokinesis, the protoplast which is binucleate, escapes by a separation of the second and third postcingular and first antapical plates. The division of the protoplast proceeds immediately while the "naked" organism swims about. It comes to rest a second time to complete division. The two daughter cells lie quiescent and do not become motile again until a new theca has been formed. The plates of the new

theca are deeply concave and the sutures are raised as prominent, sharp flanges.

As observed in Kansas, *P. palatinum* is an organism of cool waters. It first appeared in November in a pool which had been sampled repeatedly during the previous months. It was scantily present throughout the winter; then, produced a bloom in March. This bloom was unique in that, except for possible bacteria, *P. palatinum* was the only organism present. In March and April it was collected as a dominant in a mixed bloom from two other ponds. Both of these ponds had been sampled many times throughout the summer and fall and had not previously yielded *P. palatinum*. By May the motile organism had disappeared from the first pond in which it had produced the "pure" bloom, and was not taken from either of the other two ponds. Bottom samples from all three ponds yielded encysted individuals.

Collected November, 1949; February and March, 1950, Old oxbow pool; March and April, Horseshoe lake and Hayden's pond, Lawrence, Kansas; and, June, 1950, by a deep tow in an abandoned clay pit, Chanute, Kansas.

***Peridinium intermedium* sp. nov.**

(Figs. 80-88)

Cellulae ovatae vel sphaericae et angulatae, 32-39  $\mu$  longae, 33-40  $\mu$  latae et dorsoventraliter subcompressae. Chromatophori pallidi vel fusi. Stigma pallidum vel rubrum. Theca levis. Scutellae 4', 3a, 6'', 5''', 1p, 2'''' dispositae.

Cells are ovate to spherical and angular, 32-39  $\mu$  long, 33-40  $\mu$  wide and slightly dorsoventrally flattened. The Chromatophores are pale to deep brown. The stigma is pale to deep red. The theca is smooth. The plate formula is 4', 3a, 6'', 5''', 1p, 2''''.

This species has features of three genera of Dinoflagellates. It has the three anterior intercalary plates as in *Peridinium*; six precingular plates as in some species of *Glenodinium*; and, one postintercalary plate as in the genus *Gonyaulax*. Both the third apical and second anterior intercalary plates are rhomboidal in shape and may touch each other or be separated by a short suture between the first and third anterior intercalary plates. The sutures of the theca are fairly prominent on the living cell as glistening lines, particularly those of the hypotheca. The girdle and sulcal rims are clearly evident. The ventral surface of the hypotheca frequently is concave on the living cell.

*P. intermedium* resembles *P. keyense* Nygaard superficially, but differs by its rhomboidal second anterior intercalary plate, the regular arrangement of the apical and intercalary plates, the presence of six, instead of seven, precingular plates and by its size. *P. keyense* is described as 45-67  $\mu$  long and 47-54  $\mu$  wide.

Collected June, 1950, abandoned clay pit, Chanute, Kansas.

Type material no. 5035, in the author's herbarium, preserved in formalin.

**PERIDINIUM GODLEWSKII Woloszynska (1916)**

(Figs. 89-93)

Cells are ovoid with a median, slightly spiraled, girdle and are very little flattened dorsoventrally. The chromatophores are small, numerous and radially arranged at the periphery. They may, at times, be

massed together and indistinguishable, or they may be elongated radially. The stigma is a brilliant red and lies in the sulcus.

The plate formula is 4', 3a, 7'', 5''', 2'''''. The theca as a whole is thin and delicate, but the sutures are quite distinct.

The living cell might easily be mistaken for *Gl. oculatum*, or *Gl. kulczynskii*, and identification is dependent entirely on the thecal characters. In the epitheca, the small size and regular grouping of the anterior intercalary plates, and the unusually large apical pore are immediately noticeable characters. On the hypotheca, the very wide rectangular sulcus is a distinctive feature. The posterior margin of the girdle and the suture margins of the hypotheca are regularly and minutely spinescent. Minute spines are scattered or in groups on all hypothecal plates. The right antapical plate is larger than the left.

Woloszynska (1916) depicted the plates of the sulcus and showed the thickened vermiform ridges of the "flagellar apparatus." The vermiform ridge of the Kansas specimens is slightly different in shape, but associated with it is a structure not shown by Woloszynska. In Figure 91 it may be seen that there is a scale-like appendage borne on the left side of the vermiform ridge and directed to the left. This appendage is very thin, arches over the sulcus, and usually is toothed along the free margin. It may be entire or there may be a few teeth at the posterior end.

Woloszynska gives the dimensions of *P. godlewskii* as 30  $\mu$  long, and 25–30  $\mu$  wide. The Kansas specimens varied from 25–35  $\mu$  long, and 25–32  $\mu$  wide.

Collected August, 1950, Green's pond, Lawrence, Kansas.

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